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REPORT
OF
HARBOR AND LAND COMMISSIONERS

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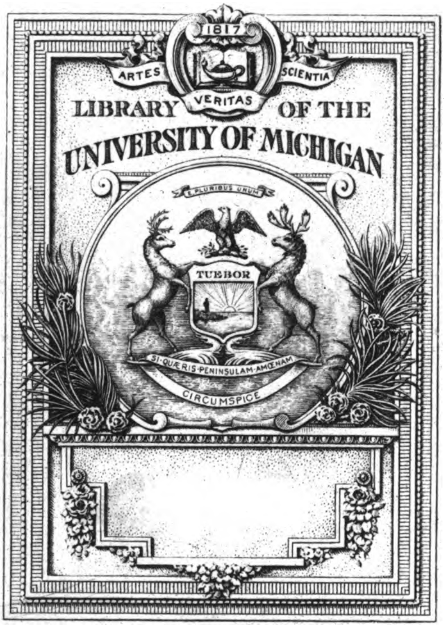

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Board of Harbor and Land Commissioners

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GEORGE M. HARLOW,

STATE HOUSE,
BOSTON.

FREDERICK N. WALES, CLERK OF BOARD.

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THIRTY-SEVENTH ANNUAL REPORT

OF THE

BOARD OF HARBOR AND LAND COMMISSIONERS.

FOR THE YEAR 1915.

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The Commonwealth of Massachusetts.

REPORT.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts.

The Board of Harbor and Land Commissioners, pursuant to the provisions of law, respectfully submits its annual report for the year 1915, covering a period of twelve months, from Nov. 30, 1914, being the thirty-seventh annual report of the Board since its establishment by chapter 263 of the Acts of 1879.

The present organization of the Board is as follows: William S. McNary of Boston, chairman, Charles C. Paine of Barnstable, George M. Harlow of Boston.

From Dec. 1, 1914, to Nov. 30, 1915, the Board has given 266 formal and informal hearings, and has received 182 petitions for the improvement and protection of rivers, harbors and foreshores, for licenses to build and maintain structures, for privileges in tidewaters, Great Ponds, Connecticut River and Merrimac River, to dredge material, to remove material from beaches and for other purposes.

Ninety-five licenses for structures and privileges in tidewaters, Great Ponds, Connecticut River and Merrimac River have been granted during the year; also 68 permits for dredging, the removal of material from beaches and for other purposes.

Inspections have been made at various times, by and under the direction of the Board, of work completed and in progress; of sites of authorized work under appropriations made by the Legislature; also upon petitions and plans presented of the sites of proposed work in tidewaters; of rivers and harbors, on petitions for improvement under chapter 481 of the Acts of 1909; work done and in progress on the Cape Cod Canal; various structures built under licenses.

During the year 42 contracts were made, involving the estimated expenditure of $560,201.14. A list of these contracts and those pending, with details relating thereto, is presented in the Appendix.

THE IMPROVEMENT AND PROTECTION OF RIVERS, HARBORS, TIDEWATERS AND FORESHORES.

By chapter 481 of the Acts of the year 1909 the Board was authorized and directed to undertake such work for the improvement, development, maintenance and protection of rivers, harbors, tidewaters and foreshores within the Commonwealth as it may deem to be reasonable and proper, and to expend during the years 1910, 1911 and 1912 a sum not exceeding $300,000, not more than $100,000 to be expended in any one year, provided, however, that an unexpended balance in any year may be used in the succeeding year.

This act also provided that the Board shall consider the general public advantage of the proposed work, the local interest therein as manifested by municipal or other contributions therefor, the importance of the industrial or commercial and other interests to be especially served thereby, and any other material considerations affecting the feasibility, necessity or advantage of the proposed work or the expenditure therefor. It was further provided that no work shall be commenced until after a public hearing has been held and a survey and estimate of cost has been made; that a city or town might appropriate money for the improvement of rivers, harbors, tidewaters and foreshores within its jurisdiction, the money so appropriated to be paid into the State treasury, to be expended by the Board for said purposes; and that the city or town might assume liability for all damages to property suffered by any person by any taking of land, or of any right, interest or easement in land within the city or town made by the Board for the purposes authorized by the act. By chapter 642 of the Acts of 1912 the Board was authorized to expend during the years 1913, 1914 and 1915 a sum not exceeding $450,000 for the purposes defined in the act of 1909 aforesaid, not more than $150,000 to be expended in any one year, except that an unexpended balance in any year may be used in the succeeding year for the said purpose.

As it has not been possible to make allotments for many projects of improvement considered necessary, owing to lack of sufficient funds, the Board recommends such further, and, if necessary, larger appropriations as the Legislature may deem advisable for the purpose of carrying into effect the intent of the act of 1909 aforesaid. This recommendation has been embodied in a draft of a bill submitted.

Petitions under the act of 1909 aforesaid have been filed during the year for surveys and improvements in the following localities: Apponagansett River, Dartmouth; Brant Rock, Marshfield; Connecticut River, at Chicopee, Hadley, Hatfield, and Holyoke; Cuttyhunk Harbor; Deacons Pond Harbor, Falmouth; Gloucester Harbor, near Five Pound Island; Ipswich River, Ipswich; Lynn Harbor, Lynn; Manchester Harbor; Mill River, Gloucester; Paskamansett River, Dartmouth; Plymouth Harbor; Red Brook Harbor, Bourne; Salt Pond River, Eastham; Salters Point, Dartmouth; Scituate Harbor; Stage Harbor and Chatham Roads and vicinity; Vineyard Haven Harbor, Tisbury; Waquoit Bay, Falmouth; Warrens Cove, Plymouth.

The action taken under these several petitions, statements concerning harbors and rivers and the various surveys, examinations and improvements made by the Commonwealth, Federal appropriations and expenditures, and extracts from the report of the Chief of Engineers, U. S. A., showing improvements made in Massachusetts rivers and harbors by the Federal government for the fiscal year ending June 30, 1915, follow.

Federal appropriations and expenditures for improvement of rivers and harbors in Massachusetts from the establishment of the government to the close of the fiscal year ending June 30, 1915, are shown in the following tables furnished by the Chief of Engineers, U. S. A.: —

TABLE No. 1. — *Localities at Present under Improvement.*

[Compiled from the annual report of the Chief of Engineers for the fiscal year ending June 30, 1915.]

LOCALITY.	Expenditures.	Appropriations.
Newburyport Harbor,	$474,248 74	$473,500 00
Merrimac River,	404,268 80	405,366 72
Sandy Bay, Cape Ann, harbor of refuge,	1,883,643 45	1,950,000 00
Gloucester Harbor,	521,184 28	542,083 00
Beverly Harbor,	48,994 59	49,000 00
Salem Harbor,	71,368 66	72,500 00
Lynn Harbor,	421,323 74	476,837 00
Mystic River (upper portion),	29,044 88	29,044 88
Mystic River (below mouth of Island End River),	263,450 58	283,005 57
Malden River,	69,750 00	150,000 00
Boston Harbor,	12,010,201 24	12,471,469 95
Dorchester Bay and Neponset River,	94,933 00	95,233 00
Weymouth Fore River,	175,095 29	175,750 00
Weymouth Back River,	26,000 00	27,000 00
Plymouth Harbor,	351,014 75	393,081 90
Provincetown Harbor,	348,062 72	365,828 44
Pollock Rip Shoals, Nantucket Sound,	220,431 42	250,000 00
Hyannis Harbor,	221,249 88	221,267 07
Nantucket harbor of refuge,	568,771 95	576,373 50
Woods Hole Channel,	343,599 92	343,599 92
New Bedford and Fairhaven harbors,	696,801 52	754,531 43
Taunton River,	200,939 92	213,000 00
Fall River Harbor,	365,978 17	381,092 15
Totals,	$19,810,357 50	$20,699,564 53

TABLE No. 2. — *Localities in which Work is not now in Progress.*

[Compiled from data furnished by the United States Treasury Department.]

LOCALITY.	Expenditures.	Appropriations.
Bass River,	$20,150 34	$20,150 41
Buzzards Bay Harbor,	2,500 00	2,500 00
Canapitset Channel,	5,312 54	9,800 00
Chatham Harbor,	15,971 36	13,732 79
Cohasset Harbor,	10,000 00	10,000 00
Duxbury Harbor,	32,000 00	37,000 00
East Dennis Breakwater,	7 57	1,500 00
Edgartown Harbor,	25,000 00	25,000 00[1]
Essex River,	30,000 00	30,000 00
Hingham Harbor,	38,316 58	39,000 00
Ipswich River,	5,617 91	7,500 00
Kingston Harbor,	8,940 09	10,000 00
Manchester Harbor,	23,985 57	24,300 00
Marblehead Harbor,	833 42	1,500 00
Marthas Vineyard Harbor,	5,000 00	5,000 00
Powow River,	50,940 72	51,000 00
Rockport Harbor,	22,000 00	–[2]
Scituate Harbor,	104,590 98	104,680 00
Town River,	18,000 00	18,000 00
Vineyard Haven Harbor,	55,387 35	60,000 00
Wareham Harbor,	95,997 30	96,236 00
Wellfleet Harbor,	11,365 57	16,000 00
Westport Harbor,	3,000 00	3,000 00
Weymouth and Town rivers,	82,327 41	83,000 00
Winthrop Harbor,	9,000 00	9,000 00
Totals,	$676,244 71	$677,899 20

Recapitulation.

Total of Table No. 1,	$19,810,357 50	$20,699,564 53
Total of Table No. 2,	676,244 71	677,899 20
Grand totals,	$20,486,602 21	$21,377,463 73

[1] Same locality.

[2] See Sandy Bay, Cape Ann, harbor of refuge.

TABLE No. 3. — *Expenditures on Boston Harbor and its Tributaries to June 30, 1915.*

[The tributaries given are those now under improvement, and do not include tributaries heretofore improved, which may be taken from preceding table.]

LOCALITY.	Expenditures.	Appropriations.
Boston Harbor proper,	$12,010,201 24	$12,471,469 95
Mystic River (below mouth of Island End River),	263,450 58	283,005 57
Mystic River (upper portion),	29,044 88	29,044 88
Malden River,	69,750 00	150,000 00
Totals,	$12,372,446 70	$12,933,520 40

The total expenditure by the State from 1893 to Dec. 1, 1915, for river and harbor work, exclusive of that in Boston main harbor as shown on page 6, Report of Harbor and Land Commissioners for 1912, was $2,775,486.10.

The total expenditures by the State for the improvement of Boston main harbor, including the Commonwealth's flats at South and East Boston, and the Commonwealth Pier, from 1870 to 1911, inclusive, were $5,406,138.79.

The expenditures by the State under the Directors of the Port of Boston, to Dec. 1, 1915, are stated to be $6,332,799.26, making the total expenditure for Boston Harbor to Dec. 1, 1915, approximately $11,738,938.05.

APPONAGANSETT HARBOR AND RIVER.

This river is about 2 miles long and is a tidal estuary of Buzzards Bay. A highway crosses the river by a causeway and bridge, with a draw, about three-fourths of a mile from its mouth. Below the highway the river is known as Apponagansett Harbor, and is used by a large number of boats, as a large part of its area has a depth of 12 feet and over at mean low water. Originally the harbor was exposed to southeasterly winds, but between 1902 and 1907 a breakwater was built by the State at the entrance, making it a very safe harbor. Above the bridge the river is broad and very shallow except for a narrow channel near the easterly shore, but being so completely landlocked it is used by a large number of small sailboats when the tide is suitable. The construction of a solid filled causeway over two-thirds of the distance across the river has undoubtedly increased the area of shoals above the same, as the waterway through the bridge is not only insufficient for the tidal flow from the river, but its location near the easterly shore has created a large slack water area on the westerly side of the stream.

Under contract of Aug. 11, 1914, with John R. Burke for dredging a channel and basin in this river work was completed Feb. 5, 1915, at a cost of $8,883.

On May 4, 1915, hearing was held on a petition of Michael Baker, and others, for the excavation of a channel and anchorage basin in this river.

On July 27, 1915, the Board gave a public hearing at the club house of the New Bedford Yacht Club at Padanaram, on a petition of Charles W. Howland, and others, for further improvement of this river. The matter of dredging above the present causeway and bridge, and the question of constructing a dam and lock therein for the purpose of regulating and controlling the height of water and creating a basin for increasing the present facilities for boating, were discussed. Inasmuch as the Board had not made a complete study of the lock and dam proposition, and plans and estimates of cost, further consideration was deferred.

Amount expended during the year, $9,433.41.

Total expenditure to Dec. 1, 1915, $50,148.76.

Barnstable Harbor.

By chapter 342 of the Special Acts of 1915 the Board was authorized to make an examination and survey and to dredge a channel and anchorage basin in Barnstable Harbor from deep water in said harbor to and into that part of said harbor known as Maraspin Creek, in such locations and to such depths as it may deem necessary and advisable. It was further provided that the Board may expend for the examination and survey and for dredging a sum not exceeding $13,500, provided the town of Barnstable accepted the act, voted to build a public wharf and landing and an approach thereto, and appropriated

$1,500 under the provisions of chapter 481 of the Acts of 1909 for dredging a part of said channel and basin; furthermore, that the town should vote to appropriate not less than $1,000 for building a public wharf and landing and providing an approach thereto.

The town at a special meeting held June 23, 1915, voted to accept this act, and made the appropriations required. Plans and specifications for dredging were prepared and proposals for the same received by the Board on July 28, 1915. A contract under date of Aug. 4, 1915, was subsequently entered into with John H. Gerrish to dredge a channel and basin, the channel to extend from the 6-foot contour in the harbor southwesterly about 1,500 feet to Maraspin Creek, thence southerly in the creek about 550 feet to the basin, the width to be 50 feet on the bottom and 6 feet deep at mean low water, and the basin to be about 150 feet wide and 300 feet long on the bottom, and 6 feet deep at mean low water. The amount of material to be removed, including the required slopes, was estimated to be about 60,000 cubic yards, scow measurement. The contract prices were: for dredging the channel and anchorage basin and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, on land and flats, including the construction of suitable dikes and all incidental work, 16.3 cents for each cubic yard of material measured *in situ;* for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $6 for each cubic yard. Up to Dec. 1, 1915, work had not been commenced.

On Oct. 6, 1915, the Board held a public hearing on petition of the town of Barnstable for approval of plans for building a public wharf and landing, as authorized by chapter 342 aforesaid, and on Oct. 26, 1915, they were approved and license granted.

Amount expended during the year, $56.60.

Total expenditure to Dec. 1, 1915, $274.11.

Bass River, Yarmouth.

Between 1901 and 1910 this river was improved by building two timber jetties at its mouth and excavating a channel between the jetties and across the flats to a depth of 4 feet at mean low water, and by providing a channel 100 feet wide on the bottom from deep water between the jetties through the flats to deep water in the Sound, a distance of about 1,700 feet. In 1911 further protective work was done on the westerly jetty.

In 1913 a survey was made to determine the existing conditions, and it was estimated that the cost of dredging the main channel and a spur channel would be about $20,400.

By chapter 250 of the Acts of 1914 the town of Yarmouth was authorized to appropriate not exceeding $2,500 for dredging the mouth of this river, any moneys appropriated to be expended by this Board; provided, however, that the Board should make no expenditures therefrom until an amount not less than five times the amount appropriated by the town is allotted by the Board for the same purpose from the appropriation made by the Commonwealth for harbor improvements.

An appropriation of $2,500 having been made by the town on Feb. 9, 1915, and an allotment of $12,500 made by the Board, a contract was entered into on April 15, 1915, with the Eastern Dredging Company to dredge a channel from the 6-foot contour in Nantucket Sound, about 2,100 feet south of the end of the jetties, to the 6-foot contour in the anchorage basin, a total distance of about 3,650 feet, the channel to be 6 feet deep at mean low water and 60 feet wide on the bottom, increasing to 125 feet at the upper end. The contract prices are: for dredging the channel and disposing of the dredged material, including boulders 1 cubic yard or less in volume, 26¾ cents for each cubic yard of material excavated measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the excavated material, $9.50 for each cubic yard. The amount of material to be removed, including the required slopes, was estimated to be about 53,000 cubic yards, and the cost of the work, including supervision and incidental expenses, was not to exceed $15,000. Up to Dec. 1, 1915, 43,174 cubic yards of material had been dredged and deposited at sea.

On June 26, 1914, a light was established by the Federal government at the outer end of the west jetty built by the Commonwealth, as an aid to navigation.

Amount expended during the year, $10,547.95.

Total expenditure to Dec. 1, 1915, $63,497.68.

BEVERLY HARBOR.

No expenditures have been made by the Commonwealth, under the direction of this Board, between 1893 and 1915, inclusive, for the improvement of this harbor.

Operations by the Federal Government.

Operations and results prior to the fiscal year. — By dredging and rock removal a channel had been obtained 18 feet deep at mean low water and not less than 250 feet wide for a distance of about 3,200 feet from Bar Beacon to Lobster Rocks Beacon, with an increase of about 100 feet in width on the northerly side about opposite Rams Horn Beacon, and not less than 200 feet wide from Lobster Rocks Beacon to the lower end of the draw pier at the highway bridge. The expenditures under the present project were $40,332.49 for original work and $265 for maintenance, a total of $40,597.49.

Operations and results during the fiscal year. — By use of Government plant and hired labor an examination was made of a portion of the channel for a reported obstruction. No obstruction was found. The expenditures were $125, chargeable to maintenance.

Condition at the end of fiscal year. — The approved project has been completed.

Local cooperation. — None.

Effect of improvement. — The improvement to 18-foot depth is reported to have effected a reduction in freight rates of 25 cents per ton on bituminous coal.

Proposed operations. — As no work in maintenance of the improved channel is necessary, no estimate of additional funds required is submitted.

BRANT ROCK, MARSHFIELD.

On March 9, 1915, a petition of the selectmen of Marshfield, under chapter 481 of the Acts of 1909, for repairs and protection of certain sea walls at Brant Rock, Marshfield, was presented. An examination of the locality was made in August, 1915, and an approximate estimate of cost prepared. A contract was entered into on Oct. 27, 1915, with Dennis F. Crowley to repair the sea wall north and south of Brant Rock, including the construction of a sub-base under portions of the face of foundation of the wall, the filling of holes in the wall, and the pointing of the joints in such places as should be directed. The contract prices were: for labor, teams and material, including transportation to and from the work, $5.20 per day for masons; $2.50 per day for laborers; $6 per day for 2-horse teams, including driver; $30 per week for foreman; $2 per barrel for Portland cement, plus 15 per cent. to be added to the above cost. The contract provided that the cost of the work, including the cost of supervision and incidental expenses, should not exceed $1,000. Up to Dec. 1, 1915, no construction work had been done.

BUCKS CREEK, CHATHAM.

Bucks Creek is the outlet of Taylors Pond in the southwesterly part of the town of Chatham, and is used as a harbor by a fleet of fishing boats. The work of improvement was commenced in 1904, and a pile and timber jetty built on the westerly side of the mouth of the creek. In 1910 and 1911 two stone jetties were built; the channel between the same was excavated to the level of mean low water, a dike across the existing channel built, and the banks of the excavated channel protected by stone riprap.

A petition of Alonzo F. Cahoon, and others, under chapter 481 of the Acts of 1909, for further improvement of this locality was presented Jan. 28, 1914. The work desired was the extension of the jetty on the west side of the channel.

On June 16, 1915, a contract was entered into with the William L. Miller Company to build a pile and timber jetty, the contract price being $9.44 per linear foot. This structure was completed July 31, 1915, and extends in a southeasterly direction about 256 feet from the end of the present westerly jetty. The cost of the work was $2,416.64.

Amount expended during the year, $2,592.24.

Total expenditure to Dec. 1, 1915, $14,289.58.

CATAUMET HARBOR AND SQUETEAGUE POND.

Cataumet Harbor is an indentation in the easterly shore of Buzzards Bay, on the boundary line between the towns of Bourne and Falmouth. The harbor, while protected from northerly and easterly winds, is open to the southwest winds prevailing through the summer months. Only a small area partially protected by a shoal afforded good summer anchorage. Leading from this harbor was a narrow and shallow channel into Squeteague Pond, which afforded an anchorage of 17½ acres with a depth of 5 feet.

By chapter 132 of the Resolves of 1914 the Board was authorized and directed to improve, among other places, Cataumet Harbor and Squeteague Pond by excavating and constructing a channel in said harbor extending into said pond, and by excavating adjacent to said channel a suitable anchorage basin for boats and vessels, and to expend therefor a sum not exceeding $25,000 in addition to such sums as might be contributed for the purpose.

Contributions having been received, a contract was entered into on Aug. 11, 1914, with the J. S. Packard Dredging Company to dredge a basin in said harbor and a channel to said pond, the basin and channel to be 6 feet deep at mean low water and the channel to be 60 feet wide on the bottom.

All work was completed July 14, 1915, under this contract and a supplemental agreement with the same contractor extending the time for completion of the work. The cost was $30,111.58.

During the year, under an agreement with Dennis F. Crowley, a timber fence 198 feet long was built on the low section of the beach separating the pond from the harbor, to prevent high tides from washing across the beach and carrying sand into the channel in the pond. Work was completed Jan. 9, 1915, at a cost of $514.80.

Amount expended during the year, $31,106.84.

Total expenditure to Dec. 1, 1915, $33,570.88.

COHASSET HARBOR.

Statements as to the improvement of this harbor by the Commonwealth in preceding years may be found in the reports of the Board for 1913 and 1914.

Complaint having been made early in 1915 that certain shoaling had taken place, an investigation was made which disclosed that the channel had shoaled in depth at various places from above Whitehead outward a distance of about 1,450 feet. On June 16, 1915, a contract was entered into with Jeremiah P.

O'Riorden to dredge the channel so that it should be 90 feet wide on the bottom and 6 feet deep at mean low water from the 6-foot contour southeasterly of Whitehead to the 6-foot contour near Dolphin No. 6. It was estimated that the amount of material to be removed, including the required slopes, was about 10,600 cubic yards. The contract prices were: for dredging the channel and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 23 cents for each cubic yard of material, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $5 for each cubic yard. All work was completed July 19, 1915, at a total cost of $2,129.80.

A map of this harbor is printed with the report of the Board for 1911.

Amount expended during the year, $2,392.81.

Total expenditure to Dec. 1, 1915, $54,263.17.

CONCORD RIVER.

By chapter 92 of the Resolves of 1915 the Board was authorized to improve that part of Concord River within the town of Billerica by removing rocks and other obstructions, and to expend therefor from the appropriation for the improvement of rivers and harbors such amount as in the opinion of the Board may be necessary and advisable, provided that the town shall pay into the State treasury $150, the same to be expended by the Board in addition to the amount which it is authorized to expend from the appropriation made by chapter 642 of the Acts of 1912.

An examination made of this river from Fordway bridge, in North Billerica, to the Bedford line, a distance of about 7 miles, disclosed that there was ample depth over the greater part of this distance for the large number of pleasure boats that use it, but that there is no commercial business; that there are lone rocks in the river at intervals for several miles most of which can be easily avoided; that immediately above the Fordway bridge the river is narrow and shallow, and the bottom appears to be covered with bowlders for a distance of about one-half mile above the bridge. It was concluded to obtain proposals at a price per cubic yard for the removal of rocks that were within a prescribed channel area. These proposals were received Sept. 1, 1915, and the Board having voted to set aside $1,500 from the funds at its disposal under authority of chapter 642 of the Acts of 1912, and the required appropriation by the town of Billerica having been made, a contract was entered into on Sept. 21, 1915, with the Cape Ann Granite Corporation to remove bowlders and ledges for the purpose of clearing a channel in this river between Fordway bridge and Corner bridge, removal to be made within the area shown on the plan accompanying the contract to a depth of 3 feet below the crest of the dam at North Billerica. The contract price for removing bowlders and ledges and disposing of the same is $7.50 per ton of 2,000 pounds. The contract provides that the cost of the work, including supervision and incidental expenses, shall not exceed $1,650. Work commenced Oct. 18, 1915, and is now in progress.

The amount expended during the year is $168.71, which is the total expenditure to Dec. 1, 1915.

CONNECTICUT RIVER.

By chapter 344 of the Acts of 1885 the Board was given jurisdiction over the Connecticut River and its banks.

Protective works were commenced on the river banks under authority of chapter 95 of the Acts of 1888, and have been carried out in various localities, the method adopted having been explained in detail in previous reports.

Chicopee. — On April 20, 1915, hearing was held on a petition of the mayor of Chicopee, and others, under chapter 481 of the Acts of 1909, for additional protective work on the bank of the river in the city of Chicopee. A survey, examination and estimate of cost were made, plans and specifications prepared, and proposals received on June 2, 1915.

On June 9, 1915, a contract was entered into with the firm of Way & Cellilli to build a concrete retaining wall with stone riprap in front of the same on the east bank of the river. The contract prices were: for furnishing materials and building the concrete retaining wall, including the cost of excavation, back filling, furnishing, erecting and removing forms, and all incidental work, $5.85 for each cubic yard of concrete measured in place in the completed work; for furnishing stone and placing it against the face of the retaining wall, including the removal of material and grading the surface of the ground, $1.35 for each ton of 2,000 pounds.

Work was completed Oct. 23, 1915, and consisted of the construction of 570 linear feet of concrete wall along the foot of the slope of the river bank, with the top of the wall at elevation 72 feet with reference to the datum plane, which is well above the highest known flood stage of the river. This wall, together with the wall previously constructed by the Commonwealth, makes a total length of 1,705 feet. The cost of this work was $5,069.63.

Amount expended during the year, $8,278.07.

Total expenditure to Dec. 1, 1915, $15,884.96.

Hadley. — In August, 1914, a letter was received from the selectmen of the town of Hadley, stating that they had been requested by citizens and property owners to call attention to the condition of the river bank on the east side of the river north of the Hadley bridge; also to the river bank on the road leading south from Hadley toward South Hadley, known as the "Fort Meadow Road." It was alleged that the river is continually wearing away the bank and washing away acres of valuable land, and that there is urgent necessity that attention be given to the river bank at the northerly end of Middle Street.

Examination having been made a contract was entered into on Sept. 8, 1914, with Dennis F. Crowley to furnish and place in position about 1,800 tons of stone riprap on the bank of the river north of the Boston & Maine Railroad bridge in Hadley, the purpose being to protect the river bank extending from the northerly end of the present riprap about 720 feet north of the railroad bridge, northerly about 600 feet. The contract price was $2.80 per ton for furnishing the stone and depositing it in place, including the removal of material, grading, etc. Work was completed Dec. 11, 1914, the cost being $5,149.28.

On Jan. 26, 1915, hearing was held on a petition of the Hampshire County Sportsmans Club, under chapter 481 of the Acts of 1909, for protective work on the bank of the river near the property of said club in the town of Hadley. An examination and estimate of cost was made. The town executed an agreement to co-operate with the Board by doing the necessary grading, filling, brushing and removal of trees on the proposed site, and on May 12, 1915, a contract was entered into with Daniel O'Connell's Sons for furnishing and placing in position about 800 tons of stone riprap on the easterly bank of the river, south of the Connecticut Valley Street Railway bridge. The contract price for furnishing stone and depositing it in place on the bank of the river, including grading of the bank, removing bushes, trees, stumps and drift, and furnishing and laying vitrified clay pipe, and all incidental work, was $2.12 per ton of 2,000 pounds.

Work was completed Sept. 24, 1915, and consisted of grading the lower part of the easterly bank for a distance of about 823 feet down the river from the Connecticut Valley Street Railway bridge, and placing riprap on the graded slope from elevation 99 to elevation 106. The cost was $1,895.56.

Amount expended during the year, $7,247.47.

Total expenditure to Dec. 1, 1915, $86,262.33.

Hatfield. — From an examination of the south bank of the river in 1914 it appeared that about 800 feet of the bank from Hatfield ferry easterly had been eroded by freshets, and that a number of large trees which were formerly fixed on the crest of the bank were undermined and liable to fall into the river. It was evident that a succeeding high freshet would remove the trees and the erosion of the bank would then proceed much more rapidly. It appeared to be necessary that the bank be graded to a uniform slope, the trees removed, and the slope covered with stone riprap from low water to the crest of the bank for a distance of about 800 feet.

On March 3, 1915, hearing was held on a petition of the selectmen of the town for protective work on the west bank of the river to stop erosion. An examination and estimate of cost was made, and the town of Hatfield having executed an agreement to co-operate with the Board by doing the necessary grading, filling, brushing and removal of trees, a contract was entered into on May 12, 1915, with Daniel O'Connell's Sons for furnishing and placing in position about

1,350 tons of stone riprap in two places on the bank of the river, the portions of the bank to be protected extending down river from the south side of the roadway at the Hatfield Ferry about 750 feet, and opposite the north end of the dike about 250 feet. The contract price for furnishing stone and depositing it in place on the bank of the river, including grading of the bank, removing bushes, trees, stumps and drift, and furnishing and laying vitrified clay pipe, and all incidental work, is $1.85 per ton of 2,000 pounds. This work is now in progress.

Amount expended during the year, $96.67.

Total expenditure to Dec. 1, 1915, $12,246.17.

Holyoke. — On April 28, 1915, hearing was held on a petition, under chapter 481 of the Acts of 1909, of John J. Murphy, and others, for protective work on the bank of the river in the city of Holyoke, adjoining the Ingleside and Bacon Boat clubs. A survey and estimate of cost of the work was made, and the city having entered into an agreement to pay the entire cost of riprapping that portion of the west bank of the river included between the boundaries of Ferry Street, and made in addition a contribution of $415 toward the cost of the work to be done, a contract was entered into on June 9, 1915, with Daniel O'Connell's Sons to build an earth dike about 120 feet long, and to furnish and place in position about 1,950 tons of stone riprap on the dike and on the westerly bank of the river. The portion of the bank to be protected extended from the northerly side of property of the Ingleside Boat Club southerly about 900 feet to a brook near the southerly side of property of the Holyoke Bacon Motor Boat Club. The contract prices were: for building the dike complete, including furnishing and laying drain and seeding dike to grass, and all incidental work, 50 cents for each cubic yard of material measured in place in the completed dike; for furnishing and placing riprap, grading of the bank and removing trees, drift, stumps and bushes, and all incidental work, $1.78 per ton of stone placed on the bank of the river and at dike.

Work was completed Oct. 16, 1915, and consisted of building an earth dike about 140 feet long across a low place in the bank of the river, removing stumps and trees, and sloping the bank and riprapping the river face of the bank and the dike from ordinary low water to the top of the bank for a distance of about 890 feet. The cost of the work was $3,713.83.

Amount expended during the year, $3,673.71, which is the total expenditure to Dec. 1, 1915.

South Hadley. — By chapter 109 of the Resolves of 1914 the Board was authorized and directed to examine that part of the east bank of the river in South Hadley between the factory of the Hadley Mills and the county bridge between South Hadley Falls, in South Hadley, and Holyoke, "and may, in its discretion, build such protective works as may be necessary to protect the bank and property near the outlet of Buttery Brook. For the purpose aforesaid the board may expend a sum not exceeding four thousand dollars, provided that the town of South Hadley shall appropriate the sum of one thousand dollars for the same purpose."

In accordance with the provisions of this resolve a survey and examination of this locality was made and a report of the Chief Engineer of the Board presented in August, 1914, which is summarized in the report of the Board for that year.

After consideration of this matter it was concluded to advertise for proposals, and the same were received on Sept. 8, 1914, and taken under advisement. Correspondence passed between the Board and the authorities of the town of South Hadley with reference to the appropriation which the town should make in accordance with the provisions of the resolve aforesaid. The town delayed action, and the Board was unable to commence the work until 1915 under a contract with Dennis F. Crowley to construct a concrete wall on the east bank of the river, between the factory of the Hadley Mills and the county bridge. The contract prices were: for excavating trench for wall, including sheeting, pumping, removal of rocks and bowlders, drilling for anchor rods, back filling, placing rock and bowlders in front of wall, and all incidental work, $2.90 for each cubic yard of material excavated; for furnishing materials and building the concrete wall, including furnishing, erecting and removing forms, furnishing and placing steel anchor rods, and all incidental work, $9.44 for each cubic yard of concrete measured in place in the completed work. It was provided that the cost of the work, including the cost of supervision and incidental expenses, should not exceed $5,000.

Work was completed Aug. 31, 1915, the wall beginning at the southerly end of the river wall of the Hadley Mills and extending in a southeasterly direction 250 feet. The wall was so constructed that it can at a later date be carried to a higher elevation if found necessary. The cost was $4,794.90.

Amount expended during the year, $4,973.22.

Total expenditure to Dec. 1, 1915, $5,045.96.

Operations by the Federal Government.

In the report of the Board for 1913, pages 44 to 48, appear extracts from a report by Maj. George B. Pillsbury, Corps of Engineers, U. S. A., under date of May 28, 1913, of a preliminary examination of the Connecticut River from Hartford, Conn., to Holyoke, Mass., made in compliance with the River and Harbor Act of March 4, 1913.

The recommendation of Major Pillsbury that such detailed surveys and estimates as are necessary to determine the cost of improvement be authorized, was concurred in, and a report of this officer, under date of April 15, 1915, on a survey of this river between Hartford and Holyoke, has been printed, with maps, in House Document No. 417, 64th Congress, 1st Session.

This report is of particular interest to Massachusetts, as it concerns the further opening to navigation of this great river. It has an exceedingly valuable bearing upon a movement which was many years ago taken up and since kept alive by individuals and organizations in the larger cities in the Connecticut valley, and which the Commonwealth, by the passage of chapter 149 of the Resolves of 1912 providing for the appointment of the Connecticut Valley Waterway Board and by a report of that special Board in 1913 on its investigation of this river, has materially advanced.

The Board has selected the following portions of Major Pillsbury's report and made the same a part of its report by reason of the conclusions of the special Board as to contributory action on the part of the cities of Springfield, Holyoke and Chicopee with respect to terminal facilities: —

SURVEY OF CONNECTICUT RIVER BETWEEN HARTFORD, CONN., AND HOLYOKE, MASS.

UNITED STATES ENGINEER OFFICE,
NEW LONDON, CONN., April 15, 1915.

From: The District Engineer Officer.
To: The Chief of Engineers, United States Army
(Through the Division Engineer).
Subject: Survey of the Connecticut River between Hartford, Conn., and Holyoke, Mass.

1. The following report on the survey of the Connecticut River between Hartford, Conn., and Holyoke, Mass., is submitted in compliance with departmental letter of August 13, 1913, and pursuant to the requirements of the river and harbor act of March 4, 1913. Report on the preliminary examination was submitted May 28, 1913, and was reviewed and reported upon by the Board of Engineers for Rivers and Harbors on July 30, 1913.

2. As a very complete and accurate general survey of this section of the river has been previously made, and the maps and data thereon published in House Document No. 231, Fifty-eighth Congress, third session operations under the present survey were limited to supplementing this data. Numerous borings were made to determine the nature of the material that must be excavated to carry out the proposed improvement and the foundations for the proposed structures; the topography of the areas affected by the construction of dams was revised and elaborated; a resurvey was made of the one small section of the river immediately above Hartford, known to have suffered material change since the previous survey; and detailed studies were made of plans for the improvement of the river and their effect on water-power development. The following maps and diagrams accompany this report:

Plate 1. Map of Connecticut River at Hartford.
Plate 2. Map of Connecticut River, Windsor Locks to Thompsonville (2 sheets).
Plate 3. Profile of Connecticut River, Hartford to Holyoke.
Plate 4. Computed water surfaces, Hartford to Windsor Locks, discharge of 3,000 and 9,000 cubic foot-seconds at Hartford.
Plate 5. Computed water surfaces, Hartford to Windsor Locks, discharge of 20,000, 40,000, and 95,000 cubic foot-seconds at Hartford.
Plate 6. Computed heights of water in tailrace of proposed power house at Enfield Rapids.
Plate 7. Flow of Connecticut River at Enfield Rapids.

A tabulation of the borings is given in Appendix B.

Enfield Rapids.

3. All plans for the improvement of the river must hinge upon the improvement of the Enfield Rapids, which lie about midway between Hartford and Holyoke, and at which the fall at low water is about 35 feet in a distance of 5 miles. Any present plan for surmounting these rapids

must be coordinated with the development of the considerable water power there available, in excess of the limited amount now utilized by the mills on the old navigation canal. As the head is comparatively low it must be concentrated, for modern hydroelectric development, in one fall, and the benefit of the high-water rise of the pool above the rapids must be realized. For these reasons earlier plans for surmounting the rapids by canalization in two lifts, or by a lateral canal, are no longer applicable. To make a lateral canal economically feasible, it would be necessary to restrict its water level to a comparatively low stage of the pool by guard gates, with an entrance lock, and the effect of a rise in the pool would not be gained at the power house. Under present-day conditions, therefore, the improvement of this section must be effected by a single dam and lock at the lower end of the rapids.

4. The location of the lock and dam must be governed by the desideratum of a suitable rock foundation. The borings made during the survey show that the underlying rock at the foot of the rapids first approaches the surface in the vicinity of the suspension bridge at Windsor Locks. As a dam here would be of great length, and would flood valuable property on both sides of the river, it appeared unnecessary to fully explore its foundation. Some distance upstream a gorge in the underlying rock was developed, running diagonally across the river in a north and south direction, and terminating a short distance below the Warehouse Point railroad bridge. The location of this gorge is clearly indicated by the borings shown on the map of the rapids, plate 2. Above this gorge rock appears at the surface and extends continuously to the head of the rapids. Inspection during extreme low water showed that the rock in the vicinity of the railroad bridge was continuous and but a few borings across the river were necessary to determine its quality. The rock here, as elsewhere in the whole reach between Hartford and Holyoke, is a soft shale sandstone, brown in color, in strata dipping slightly to the east and northeast. The surface rock is not sound, but the quality improves with the depth, and it is unquestionably suitable for the foundation of a dam of proper design. Inasmuch as a suitable site for the lock and dam exists upstream of the gorge in the underlying rock that has been referred to, the question of constructing a dam across this gap may be dismissed, and the lowest suitable site for the lock and dam may be fixed as immediately downstream from the Warehouse Point railroad bridge. Plans for improvement are based on the location at this point of the lock to surmount the rapids.

Improvement below Rapids.

5. Between the Enfield Rapids lock site and Hartford the river has now a fall at low water of about 12 feet in the total distance of 13.2 miles, the greater part of this fall occurring in the 2 miles intervening between the site for the new lock and the existing entrance locks into the old canal. The river throughout is broad and generally very shallow. The available depth at low water below the old locks is but between 2 and 3 feet. Above

the old locks navigation can be carried on only during a rise in the river, the depth at low-water stage being, under present conditions, insufficient for navigation of any kind. It is evident that very extensive improvement will be necessary to secure a channel from Hartford to the proposed lock of depth sufficient for present-day navigation. The choice of method lies between open-channel excavation with regulating works to assist in its maintenance, and canalization by a lock and dam just above Hartford, supplemented by dredging.

6. The depth of a channel necessary for present-day commerce was considered in the report of the preliminary examination. It was there pointed out that, to render the improvement commercially successful this depth must be sufficient for vessels of considerable carrying capacity, suitable for navigating Long Island Sound. Such vessels must have depth that they may be stiff enough to meet rough water. Experience has amply demonstrated that a normal channel depth of 12 feet is necessary for vessels of this character. This is, in fact, the present project depth of the river below Hartford, a depth certainly no greater than is necessary. The minimum width of channel may be placed at 100 feet, suitably increased at bends in the alignment. A depth of 12 feet at the chosen low-water datum and width of 100 feet, has therefore been selected for the channel dimensions. An enlargement in width is necessary, as will later be shown in the portion of the channel immediately below the lock site.

Open-channel Improvement.

7. It is apparent that the excavation of an open channel of the dimensions proposed, through the shallow reach between Hartford and the lock site at Enfield Rapids, will greatly reduce the existing slope of the river at low-water stages, and that the computation of the amount of material that must be removed to secure the channel must be based on the predicted rather than the actual slope. The predicted slope was calculated by an accepted formula, the coefficient of which was determined from the actually observed slopes, as is more fully detailed in Appendix A. The predicted total fall at low water after a channel 100 feet in width and 12 feet in depth has been excavated to the lock site, was found to be about 1.5 feet. An enlargement in the width of the channel to 200 feet, which may be foreseen, would reduce the fall to 1 foot. It may be observed that the predicted slope is approximately the same as the natural slope of the river below Hartford. It is evident that with so slight a slope any still greater enlargement of the channel, either in consequence of the action of the regulating works or future increase in the project, could not reduce the slope sufficiently to be of material consequence to navigation, nor could a diminution of the flow have such effect. On the other hand, when the surplus water power at the rapids is developed the discharge of the stream through the power plant must be varied to meet the fluctuating demand for power, with the result that the flow through this section of the river will, during considerable daily periods in the low-water season, fall

below the present minimum flow, for which the slope was computed. A slope exceeding 1 foot in the 13.2 miles considered can not, therefore, be expected. The mean low-water datum, after open-channel improvement has been effected, is therefore taken as sloping from its present established height of +2 feet above Hartford datum at Hartford to +3 feet above Hartford datum at the proposed lock site.

8. On account of the diminished slope of the water surface, the portion of the channel extending through the lower part of the rapids to the lock site will be deeply cut into the bed of the river, and must consequently carry the entire river flow up to moderate discharges. It must therefore be given a cross section sufficient to pass this flow with current velocities suitable for navigation. The channel width estimated necessary to this end, the effect of variations in flow on account of the operation of the power house being considered, is 250 feet at the upper end, gradually decreasing to the normal width of 100 feet opposite the present locks into the old canal. For the basis upon which these widths were determined, reference is made to Appendix A.

9. The material to be excavated for the channel was reasonably well explored by borings made during the survey, and was found to be sand from Hartford to Bissells Ferry, 7.3 miles; sand, loose gravel, and soft clay, with a small amount of soft rock, from this point to the foot of the old locks, 3.6 miles; compact, heavy gravel and soft brownstone rock through the lower rapids. In the approach to the lock site, through the gorge in the bedrock that has been described, the material is again loose gravel. The estimates of cost are based on disposing the sand and loose gravel hydraulically on the shoals of the river. Rehandling will probably be necessary to dispose of the material in the lower rapids. The heaviest rock cut in the rapids is so located that it can probably be advantageously excavated in the dry behind a coffer.

10. In order that the channel may be maintained at a reasonable cost, dikes will be necessary to direct and confine the flow and to prevent the excavated material from being washed into the channel during floods; and revetments will be required to prevent the confined flow from cutting the opposite banks. It may be expected that much of the rock and heavy gravel excavated from the lower rapids will go into these works. The lines of these dikes must be regulated by trial and experience, and detailed estimate of their cost can not well be made in advance. The length of river to be so treated is 11 miles, and the cost, after full consideration of the subject, is placed at $50,000 per mile.

11. The cost of the open-channel improvement of the section from Hartford to the foot of the guide wall of the proposed lock at Enfield rapids is, then, estimated as follows:

Hydraulic excavation, 3,400,000 cubic yards, at 16 cents	$544,000
Rehandled material, 650,000 cubic yards, at 50 cents	325,000
Rock, 115,000 cubic yards, at $3	345,000
	$1,214,000
Regulating works	550,000
Administration, superintendence, and contingencies, about 15 per cent.	266,000
Total	$2,030,000

Canalization.

12. The canalization of the river between Hartford and the lock site at Enfield Rapids involves the construction of a dam and lock near Hartford (pl. 1). The site farthest downstream suitable for the construction of these works is about 1.5 miles above the Hartford Bridge. Below this point the conformation of the banks is not as suitable and the land for abutments is more expensive, while the dredging necessary to secure an open channel is comparatively light. The bed of the river here, as for some miles up and down stream, consists of a stratum of coarse sand some 15 feet in thickness, overlying soft red clay, the latter extending to rock at considerable depth. While the foundation conditions are not of the best, there is no question of the stability of a properly designed lock and dam. An alternative site, affording rock foundation for the lock, occurs at Wilsons, about 2 miles farther upstream, but the ledge dips so rapidly toward the river that it will not afford a foundation for the dam. The cost of excavating and maintaining an open channel between the two sites considerably overbalances the saving in first construction that would be realized at the upper site from the more favorable lock foundation.

13. The general plans for the lock and dam provide for a lock chamber 310 feet in usable length and 45 feet in width, conforming to the dimensions of the locks in the New York State Barge Canal. The height of lock walls is 16 feet above Hartford datum. Based on a record of 17 years, a lock of this height will be flooded but 13 days in the year when the river is otherwise navigable, on an average, and but 22 days in the year as a maximum. The dam has a length of approximately 1,000 feet. It is designed to afford a pool elevation of 9 feet above Hartford datum and has a movable crest at this elevation, with fixed crest at elevation 6. These heights are fixed upon to secure the maximum pool height that will not injuriously affect the existing water-power development at Windsor Locks, nor restrict any future development to a greater degree than natural conditions impose. A dam with a fixed crest at the low elevation stated will have but a very trifling effect on the flood heights of the river, particularly if it be given a cross section of high hydraulic efficiency when deeply submerged. For this reason it is believed entirely unnecessary to incur the somewhat greater first cost of a dam of the movable type, with its much greater cost of operation and care. The experiments on submerged weirs made for the International Waterways Commission, and recorded in the

final report of that body (S. Doc. No. 118, 63d Cong., 1st sess.), indicate a cross section from which high efficiency of flow may be expected, and this section was chosen as the basis for that of the fixed portion of the proposed Hartford Dam. In other respects the design of the dam and lock follows established practice. For the movable crest the drum-wicket type is proposed, operated in two sections to facilitate the regulation of the pool. The estimate of cost of the lock and dam is as follows:

Lock	$225,000
Dam:	
Fixed parts, 1,000 feet, at $265	265,000
Movable parts, at $30	30,000
Abutment	30,000
Cofferdam and pumping	75,000
Bank revetment, 10,000 feet, at $4	40,000
Lands, buildings, and power machinery	50,000
Superintendence and contingencies, about 15 per cent.	110,000
Total	$825,000

14. The pool created by the dam must be improved by dredging to secure a channel of 12-foot depth and 100-foot width. As with the open channel, the width must be increased in the lower rapids in order to accommodate the flow at velocity suitable for navigation, but this enlargement need not be carried so far. The channel widths estimated as necessary decrease from 250 feet at the entrance to the Enfield Lock to the normal width of 100 feet at a point somewhat downstream from the suspension bridge at Windsor Locks. The estimated cost of excavating this channel is as follows:

Hydraulic excavation, 1,400,000 cubic yards, at 18 cents	$252,000
Rehandled material, 230,000 cubic yards, at 50 cents	115,000
Rock, 17,000 cubic yards, at $3	51,000
Superintendence and contingencies, about 15 per cent.	62,000
Total	$480,000

The higher unit price is assigned to the hydraulic excavation under the canalization plan on account of the smaller quantity to be excavated.

It is further estimated that the sum of $100,000 can be profitably expended in the construction of dikes, training walls, and revetments to reduce the cost of maintenance.

15. The total cost of canalization, from Hartford to the lock site at Enfield Rapids, is therefore —

Lock and dam	$825,000
Channel excavation	480,000
Regulating works	100,000
Total	$1,405,000

The estimated first cost of the improvement of the reach by canalization is, therefore, but approximately two-third of the estimated initial cost of the open-river improvement. To the difference in cost of the two plans of channel improvement must be further added the cost, estimated at $75,000, of additional lift of the lock at the rapids made necessary by the open-channel improvement.

Comparison of Plans.

16. The cost of maintenance under the two plans is difficult to forecast. But little previous dredging has been done in this section, and the channels that have been excavated were quite narrow and of comparatively slight depth, so that they modified but slightly the circumstances of the river flow. A channel dredged in 1873, 35 feet in width and 4.5 feet in depth, through a shifting bar about 3 miles above Hartford is reported to have filled before the next season. A channel of approximately the same dimensions, dredged in 1909 by the Springfield Navigation Co., through a gravel bar farther up the river, remained open for a number of years, and was last summer restored by that company at small cost. The tendency of the current to follow and clear the channels now proposed would be far more marked, on account of their much greater size, and such channels would not fill to the same relative degree. Below Hartford, the amount of material that is dredged yearly from the bars to maintain the 12-foot channel, averages about 100,000 cubic yards, the total length of channel where dredging is required there aggregating 5 miles. The depth of shoaling during freshet rarely exceeds 2 feet at any place. For the proposed channel above Hartford the length of dredged cut will be much longer, and the natural depth of the river far less. On the other hand, the material at the upper end of the reach is much heavier, and will be reasonably stable even under the spring floods. The regulating works provided for in the estimate will go far toward preserving the channel, and the comparatively great amount of material will justify the employment of a dredge of high efficiency. I believe that the estimate for maintaining the open-channel improvement from Hartford to the Enfield Lock site can be placed, with reasonable safety, at $45,000 per annum; and the cost of annual dredging necessary to maintain the channel in the canalized river at $30,000 per annum. The cost of the operation and care of the lock and dam may be placed at $10,000, so that the total cost of maintenance and operation, under the canalization plan, is $40,000. It may be seen, therefore, that, so far as concerns the item of maintenance, the difference between the two plans is not great. It might, indeed, be thought that the pool formed under the canalization plan would gradually fill, rendering its maintenance eventually nearly as costly as that of an open channel. It may be confidently predicted that such will not be the case. At flood stages, during which alone shoaling of moment occurs, the dam will create a mere local disturbance of flow. At such stages the currents and velocities of the river will be unaffected by it except in its immediate vicinity, where

a slight increase of velocity will occur. There is no progressive shoaling in the pool above the existing Enfield Dam, and none may be expected as a consequence of the erection of the proposed Hartford Dam.

17. So far as concerns their relative advantages to navigation, there is likewise little to choose between the two plans. The freer navigation in the pool provided by canalization will be offset in large degree by the delay and inconvenience of lockage. Canalization will afford greater facilities for delivering fertilizer to the rich farm lands that border the river and will improve the navigation of the lower reaches of the Farmington River, making it possible for small cargoes to reach the town of Windsor on that tributary. It will incidentally add greatly to the attractiveness of this reach of the Connecticut for pleasure boating. It must, nevertheless, be recognized that the community affected might, as a whole, prefer the open-channel method, in the prejudice that a fixed dam, however low, would increase the flood heights to an injurious extent.

18. The improvement of the river below the rapids by canalization can therefore be accomplished at much less cost than by open-channel improvement, its maintenance will probably be somewhat less costly, and it will afford somewhat greater advantages to navigation. With a dam of the height proposed it will not materially injure the water power already developed at the Enfield Rapids, nor will it restrict the development of additional power to a greater degree than natural conditions now impose. On the other hand, the open-channel improvement would create a new and artificial condition in the river by which the available head at a future water-power development would be increased, particularly in low-water periods, with a consequent increase in power. An investigation into the amount of this additional head was believed desirable, with a view to determining whether its value would be sufficient to justify the adoption of the open-channel method under a plan of cooperation with the company operating the power plant under which the latter might secure the advantages of the open-channel improvement by bearing its added cost.

19. To determine the consequences of the various plans, the slopes of the river at various discharges were calculated, for the open-channel improvement, the canalized improvement, and the river in its present condition improved only by a tailrace at the power plant. The amount of tailrace excavation that a power company would find profitable for power purposes alone depends upon a number of none too definite elements. The decision as to the extent of the tailrace excavation that would be profitable if no improvement of the river for navigation was involved would depend largely on the judgment of the hydraulic engineer designing the plant. Very extensive tailrace developments are quite rare. For the purpose of this computation there has been taken a development approximately equivalent to that shown in the plan presented in 1909 by the Northern Connecticut Power Co. (printed in H. Doc. No. 818, 61st Cong., 2d sess.), differing therefrom only in that the bottom width was made 300 feet, with a more direct alignment. The plan presented by that company

was drawn with a view to meeting navigation requirements as well as those of power. Further study indicates, indeed, that it would have fulfilled the first end but imperfectly; but it is very doubtful whether a greater development would ever be made for power only. The computations of the water slopes under this development and under the two comprehensive plans for navigation improvement were made by methods detailed in Appendix A, with the results shown on plates 4, 5, and 6.

20. From these diagrams it will be seen that the effect of any plan considered on the existing water powers at Windsor Locks will be small. The mills developing the power draw the water from the old navigation canal and discharge it through separate tailraces into the lower rapids. The elevation of the tailraces have been plotted on the diagrams. All lie above the proposed pool surface at low discharge. To avail themselves of the additional fall available at low water between the tailraces and the surface of the river in the natural channel, or of the greater fall that would be afforded after the river was improved by the open-channel method, it would be necessary for the mill owners to incur the very large cost of excavating deep tailraces through the ledge which lies along the west bank of the river, and probably also to incur an annual expense in clearing these cross-channels of deposits. This fall has not been availed of, and it may be assumed that the cost of realizing it is prohibitive. The canalization of the river, so far as the existing water power is concerned, would therefore merely absorb that portion of the head which the mills can not profitably utilize, and would consequently cause them no injury whatever.

21. The effect of the several methods of improvement on a future comprehensive development of water power is shown on plate 6, prepared from the data shown on plates 4 and 5. This diagram shows the heights of water in the tail-bay of the power house of such a development, corresponding to any given river discharge, under the various plans. It will be noted that the computed river heights are practically the same for the improvement by canalization as for power development only. The extensive channel excavation included in the former compensates for the backing up of the water by the dam. At very low flows, to be sure, a loss of head amounting to about 1 foot is indicated, but such flows are of but brief duration and produce but a very limited amount of power in any event. The open channel improvement of the reach from Hartford to the lock and power house on the scale contemplated will, on the contrary, increase the available head at the power house by as much as from 2 to 5 feet through a considerable range of river discharge.

22. To arrive at an estimate of the benefit to be gained by an increase of head, which varies quite rapidly with the amount of discharge, it is necessary to ascertain the amount and distribution of the discharge. Since no extended records of the discharge of the Connecticut at the Enfield Rapids have been made the carefully kept records made by the Holyoke Water Power Co. of the discharge at Holyoke, 18 miles upstream, for the 20-year period, 1880–1899, are used for this purpose. The drain-

age area above the rapids exceeds the drainage area above Holyoke by 15½ per cent of the latter, and the Holyoke discharges were accordingly increased by this percentage to give the discharge at the rapids. The Holyoke data is largely based on computations of the water passing through the wheels of the Holyoke mills. The tendency of such determinations is to give too low results. A direct comparison of the Holyoke discharge with measured discharges at Enfield is given in Appendix A. Without going into further details it may be said that, in fact, the Holyoke records show a lower flow per square mile than any other records in the lower part of the river. As they are, however, the best long-term records at a near-by point, and as they underestimate rather than overestimate the flow, they are believed the most desirable basis for the present computations. To present them in a convenient form the discharges for the 20-year period were arranged in order of magnitude, giving the duration curve of discharge shown on plate 7.

23. From the data presented it may very readily be shown that the average gain in head secured for a future development of water power at the Enfield Rapids by the adoption of the open-channel improvement of the reach between Hartford and the lock at the rapids will be about 2.8 feet. The total available head with the river in its natural condition, or after its improvement by canalization, will normally be in the vicinity of 30 feet, so that the relative gain in head will average about 10 per cent. It by no means follows, to be sure, that the power, and more particularly the value of the saleable power, will follow the same ratio as the head. The largest gains in head occur at low discharges when the power affected is the least and the gain in the total annual power proportionately less than at higher discharges. A computation of the amount of saleable power, either absolute or relative, gained by the adoption of the open-channel plan, can be made only after the determination of a number of features of the development, such as the capacity of the plant, the operating-load factor, and the extent to which the new development will supplant the wheels now installed on the old navigation canal, all of which are largely dependent upon the circumstances of the market. Tentative estimates, based on reasonable assumptions, show that the adoption of the open-channel improvement will increase the saleable power by an amount somewhat less than 10 per cent but not greatly differing from that figure. The average gain of 2.8 feet in head may be taken, therefore, as an index of the value of the open channel from the water-power standpoint. The expenditure necessary to realize the additional head may be summarized as follows:

Excess cost of open-channel improvement	$625,000
Added cost of lock at Enfield Rapids	75,000
Added cost of draft tubes and tail-bay excavation at power house	75,000
Total	$775,000

I believe that the benefits gained either to a private corporation or to the general public by increasing the average available head at Enfield Rapids by the moderate amount of 2.8 feet would not justify this expenditure. Adequate cooperation by private interests to secure the open channel improvement in lieu of improvement by canalization is not therefore to be anticipated, and the latter plan is consequently that best suited to the conditions.

24. In view of the heavy excavation necessary to secure a river channel through the lower rapids to the site of the lock, the thought may suggest itself that a lateral canal to serve navigation through this reach might accomplish the end at less cost. Even preliminary investigation shows, however, that such is not the case. The length of canal required would be approximately 2 miles. A lock at the proposed Enfield Dam could not be dispensed with, as a guard lock would be necessary even were the canal carried at the upper pool level. The estimated cost of the river channel through the lower rapids under the canalized plan is $180,000. Taking into consideration the initial cost of constructing two locks instead of one, and the cost of acquiring the land and excavating a canal of the required length, it is immediately apparent that the initial expense of the lateral canal would exceed the cost of the river channel. Excluding the improvement of the lower rapids, the estimated cost of the channel from Hartford is practically the same whether open-channel improvement or canalization be adopted, so that the cost of an open channel to the foot of the rapids, with a lateral canal to the dam, would considerably exceed the cost of canalization. A lateral canal consequently offers no advantage in first cost, and the operation and care of the added lock would be more costly than the maintenance of the river channel.

Improvement above the Rapids.

25. The section from the rapids to the head of navigation at Holyoke has a gentle slope and a depth exceeding, in some reaches, that desired. Neither its initial improvement nor its maintenance offer any unusual features. Through the greater portion of the rapids the pool created by the proposed Enfield Dam will afford the necessary depth. In the upper part of the rapids and immediately above the present Enfield Dam there will be a considerable length of shallow rock excavation, in soft brownstone, necessary to gain the required depth. Above this all indications and all probings show that sand only will be encountered.

26. The mean low-water pool elevation of the existing Enfield Dam is 40.9 feet above Hartford datum. The limiting height of the dam as fixed by the court decree may, however, be interpreted to be 39.41, and this latter height has been accordingly adopted as the basis of mean low-water datum on which estimates of excavation are based. The mean low-water slope can not differ materially from that of the present pool. This slope gives a total fall of but 0.4 foot in the whole distance of 18 miles.

27. The estimated cost of a channel 100 feet in width and 12 feet in

depth below the pool level created by a dam at elevation 39.41, Hartford datum, is as follows:

Hydraulic excavation, 1,000,000 cubic yards sand, at 15 cents	$150,000
Rock, 85,000 cubic yards, at $3	255,000
Administration and contingencies	60,000
Total	$465,000

The estimated cost of maintenance in this section is $15,000 per annum.

Lock and Dam at Enfield Rapids.

28. To complete the improvement and make it of use to navigation, a new dam, with a suitable lock, must be constructed at the Enfield Rapids. During recent years several applications have been before Congress for authority for the construction of such a dam, for the purpose of developing the considerable water power that now runs waste. Mr. Charles H. Tenney, president of the Connecticut River Co., the proprietor of the present water-power development at the rapids, states, in a letter attached, that the company is prepared to commence construction on a new dam at the foot of the rapids as soon as authority therefor is obtained. A power development of proper design and construction, built with due economy by a company having sufficient capital for the purpose, and operated under good business management, should apparently gain a reasonable return on the necessary investment, provided that the conditions imposed under the grant of authority were not unduly onerous. There is good ground for anticipating, therefore, that the dam and appurtenant lock will be constructed by private capital after the necessary authority has been granted.

29. It does not appear to the public interest, however, to rest the development of a considerable interstate commerce, of great benefit to a large community, wholly on the initiative of private interests in the development of water power. If the lock and dam necessary to surmount the rapids are not constructed by private interests within a reasonable period, and if the improvement of the river for navigation is deemed desirable, the United States could appropriately construct these works, and make the excess power thereby made available the means of producing a return on its expenditure. With this end in view, an estimate of the cost of the lock and dam, with the necessary foundations and sluices for a power house, together with an estimate of the overflow damages, is presented. These estimates are based on a lock with chamber 310 by 45 feet in dimensions, provided with intermediate gates to reduce the water consumption when passing small vessels. The height of the main lock walls is 45 feet above Hartford datum. With this elevation the lock will be usable as long as the lock in the proposed Hartford Dam is in operation. The head walls and gates are at elevation 54, to carry them above extreme flood height. The lock is located on the west side of the river immediately downstream from

the Warehouse Point railroad bridge. The power-house foundations and sluices are adjacent. A diversion dam 1,700 feet in length, of which 700 feet is of spillway, and 1,000 feet retaining section, extends from the lock and power house to Kings Island; the east branch of the river being closed by spillway 1,160 feet in length, with crest at elevation 39.41, Hartford datum. Suitable head works for the present canal are included. A dike is provided to separate the tailrace and approach channel from the main river. This dike need be but of comparatively low height. At high discharges the slope of the lower river drowns out the lower rapids, and there is then no occasion for separating the tailrace and channel from the remainder of the stream. The estimate of cost of the lock, dam, and appurtenances is as follows:

Lock	$380,000
Dams	680,000
Power-house foundations and sluices	205,000
Tail-bay excavation	150,000
Dike	10,000
Head gates into old canal	12,000
Cofferdam, pumping, temporary flumes, etc.	150,000
Removal of old dam	5,000
Administration and contingencies, about 15 per cent	238,000
	$1,830,000
Lands and damages	250,000
Total	$2,080,000

30. The areas submerged by the erection of the dam would be limited to those between its site and the present dam, lying below elevation 39.41. The effect of the proposed dam on flood heights and the consequent area of overflowed lands is discussed in Appendix A. It is there shown that the practical effects will be also limited to the portion of the river between the new and the old dams, provided that the old dam is removed after the new one is constructed. Between these sites the banks are generally high and rocky, and but little land, and that generally of small value, would be either permanently submerged or overflowed in flood. The head at a small water power on Stony Brook, at present unused, would be greatly reduced, and changes, not involving change in the track elevation, would be necessary in a portion of the Warehouse Point railroad bridge. The estimated cost of lands and damages, exclusive of undeveloped water power, is consequently not a large figure.

Water Power.

31. The amount of useful power that is obtainable from the flow of the stream in excess of the flow used by the mills on the present navigation canal (taken at 1,500 cubic feet per second), and the requirements for lockage at the proposed lock (taken at 200 cubic feet per second), based on a plant of 30,000 horsepower capacity, operating at a 50 per cent load

factor for 300 days in the year, is approximately 63,000,000 kilowatt hours per annum as an average, and ranges from 55,000,000 kilowatt hours in dry years to 80,000,000 kilowatt hours in years of abundant flow. The flow of the river exceeds the requirement of a plant of this capacity somewhat more than six months in the year. It is assumed that sufficient pondage will be available in the pool above the dam to permit full advantage to be taken of the flow when less than that necessary to meet the capacity of the plant. In the computations hydraulic conversion efficiency was taken at 80 per cent, electric at 90 per cent. As the value of this power at the generating station after conversion into electric energy may be taken at about 4 mills per kilowatt hour, and as the large manufacturing communities in the vicinity should offer a good market for power, a leasing charge for the water-power privileges as developed by the construction of the dam, power-house foundations, and sluices would not be excessive if based at 1.5 mills per kilowatt hour. Such a charge is approximately at the rate of $7.50 per horsepower per annum. The leasing value of the power privileges of a dam constructed for the improvement of the Enfield Rapids may therefore be estimated at $100,000 per annum; a sum that would in itself yield a fair return upon its cost.

32. The flow required for the operation of the proposed lock should be amply covered by the average daily draft of 200 cubic feet per second assumed. This amount will afford 40 lockages per day for a lock 310 by 45 feet in area, with the maximum lift, provided that the gates and valves are made sufficiently tight, as they can be, to duly limit leakage. While it may be expected that launches and other small craft will require the fairly frequent operation of the lock during daylight hours, in addition to the demands of commercial vessels, the use of intermediate gates for locking through such craft should keep the water consumption well within the limit stated.

Pondage.

33. Whether the dam be built and the power plant operated in normal course by private interests, or the dam built by the United States and the power privilege leased, the stream should be made to yield the greatest amount of useful power that can be had without unreasonably infringing upon its uses for navigation. During the periods when the flow is insufficient to continuously meet the full capacity of the plant, the operating company should be allowed to pond the water received in excess of its needs in the hours of minimum power demand for utilization during the hours when it is most useful. It is obvious that such pondage can be secured only through a fluctuation in the pool surface. The upper limit of the fluctuation, if no water is to be lost, is determined by the crest of the dam, whether it be the masonry crest or flashboards surmounting it. As the pool reaches to the tailraces of the lower Holyoke mills, the raising of the pool surface will work injury, more or less material, on those water powers. A height of crest that will do no material injury was determined by the United States district court in the case of the Holyoke Water Power

Co. *v.* The Connecticut River Co. and fixed at an elevation which may be interpreted as 39.41, Hartford datum. The lower limit of the pool fluctuation must be such as will not unduly impair the navigable capacity of the waterway. Inasmuch as a considerable amount of dredging and rock excavation is necessary to secure a channel of projected depth when the pool, at the dam, stands at elevation 39.41, a certain impairment of navigable capacity will result from any reduction in pool level; but it will not be unreasonable if it subjects navigation to no greater inconveniences than are encountered in the channel giving access to the pool. On the other hand it would be unreasonable to draw down the pool below the stage at which, in its natural state, it would yield commensurate pondage. In the channel below Hartford, which must be traversed by vessels en route to the section under consideration, and in which the project depth is the same as that proposed for this section, the water falls at lowest tides during lowest flows 1.5 feet and more below its mean low level. A temporary reduction of 1.4 feet in the Enfield pool would not consequently appear unreasonable. The resulting pool surface, at elevation 38 at the dam, is, from the records, the extreme low stage of this section before the Enfield dam was closed across the river. The bed and banks of the stream have changed but little in the intervening years. It follows, therefore, that, with the river in its natural state, the pondage obtainable below pool elevation 38 would be substantially limited to that derived from the section below the head of the rapids, the area of which is but 24 per cent of the area of the whole stream. I believe, therefore, that the minimum elevation of the pool should be fixed at elevation 38, Hartford datum.

34. It is very probable, indeed, that the water-power company will find it inadvisable on other grounds to draw down the pool below elevation 38. A portion of the water carried by the present canal is delivered to manufacturers under long-term leases, and it may be anticipated that its delivery must be maintained. The present water surface of the canal opposite the proposed intake is a trifle above elevation 38. If the pool is drawn down below that level, expensive alterations in the canal and in the forebays of the mills will probably be required to continue the supply.

35. It may not be inappropriate to inquire whether the pondage afforded between these comparatively narrow limits will be sufficient for the profitable operation of a power plant of the character considered. Pondage will be used, (1) to utilize the whole flow of the stream up to the capacity of the generating machinery installed while supplying an hourly varying demand for power; (2) to combine in the most profitable manner the output during low flows with the auxiliary power then necessary; (3) to compensate for the irregularities introduced in the natural flow of the river by the withholding and releasing of water at upstream dams.

36. So far as the first of these features is concerned, computations show that the pondage afforded between the limits considered should be reasonably adequate. With a plant of the capacity that has been considered, 30,000 horsepower, supplying a well-distributed load, which would give as

high a power factor as 75 per cent, detailed computation shows that the pondage would be adequate so long as the inflow into the pond was uniform and steady. Considering a plant of greater capacity, 40,000 horsepower, operating on the daily load curve actually realized at a similar plant (67 per cent load factor), computation shows that under these conditions the maximum loss of water, through lack of sufficient pondage, would amount to but 2½ per cent of the discharge for the day. This loss would occur when the inflow was just sufficient to meet the average demand and would be less when the inflow either exceeded or fell short of this point. Without any pondage the maximum loss for such a plant operating under these conditions would be about 12 per cent of the discharge for the day. In these computations the varying slope of the pool from hour to hour was taken into consideration, as was also the water stored in the rise of the pool, which must be contemporaneous with an overflow at the dam. The data and method of computation are set forth in Appendix A.

37. The second feature, that of combining the water power to best advantage with auxiliary power during low flows, would, I conceive, be met if the water power is made to carry the peak of the load during such periods. If the pondage is sufficient to carry the whole of the varying load at full development it will evidently be sufficient to carry any portion of the variation at less flow. Detailed computation shows that with the actual load curve just referred to the whole flow could be applied to the peak of the load at low flows without loss of water.

38. As to the third feature, the irregularity in flow due to the operation of the upstream plants, it may be said that minor irregularities, such as those occurring from hour to hour, disappear in the long pool between Enfield and Holyoke. The operation of a future plant at Enfield is concerned only with the gross irregularities resulting from the closing of the headgates at Holyoke on Sundays and holidays and during times of extreme low flow. The greater portion of the Holyoke mills shut down at the close of work on Saturdays, resuming operations Monday morning. During the intervening time a considerable portion of the flow of the river is stored in the Holyoke pool. Moreover, when the flow received in that pool is insufficient to meet the amount that the various mills at Holyoke draw under their leases with the Holyoke Water Power Co., and the pool is consequently drawn down to an undesirable level, the headgates of the power canal are closed and the pool is allowed to fill. Nearly the entire flow of the river is then shut off. It is stated that the maximum duration of such interruptions is about 36 hours, and the number of interruptions in a year has not exceeded 18. As a considerable part of the power generated at the proposed plant at Enfield will probably be sold for manufacturing purposes, the interruption of the Sunday and holiday flow will be most seriously felt on the following mornings in the hours required for the flow released from Holyoke to reach Enfield. More pondage than can be secured by drawing down the pool to elevation 38 will probably be re-

quired to afford advantageous operation of the plant and to preserve to the output its due value on the mornings following Sundays and holidays and on working-day interruptions to the normal flow of the river if the crest of the dam is limited to elevation 39.4. Should such be found the case, the situation has, nevertheless, a remedy, for sufficient additional pondage to carry the plant over such interruptions could be secured by placing flashboards on the dam. Such a course would be a matter for private agreement or judicial adjustment and is beyond the scope of the present report. It is sufficient to point out that the question of obtaining sufficient pondage without drawing down the pool below elevation 38 is not an insuperable obstacle to power development.

39. As to the consequential effect of pondage in reducing the flow below the dam during the hours of storage, it may be observed that such reduction, with the improvement of the river below the rapids secured by canalization, will be immaterial. An entire temporary cessation of flow could have but little effect on the channel depths. It will be unnecessary, therefore, to regulate, in the interest of navigation, the amount of water released.

Summary of Cost.

40. The total cost of initial improvement, supposing that the dam and appurtenant lock are constructed at the Enfield Rapids by private interests, is —

Below rapids, by canalization	$1,405,000
Above rapids	465,000
Total	$1,870,000

The cost of maintenance is estimated at $45,000 per annum. The cost of the operation and care of the locks at the Hartford and Enfield Dams, and of movable crest of the former, is estimated at $20,000 per annum. The total cost of upkeep is therefore estimated at $65,000 per annum. Should the United States construct the lock and dam at the Enfield Rapids the initial cost would be increased by $2,080,000, making the total cost $3,950,000, with an expected return for the lease of water power of $100,000 per annum.

Commerce.

41. The prospective commerce to be developed by the improvement was set forth in the report of the preliminary examination, paragraphs 25 and 32. It was there stated that a commerce amounting to about 700,000 tons per annum is to be anticipated, and that the saving in freight by an adequate system of water transportation, over the present rail cost, would be in the vicinity of $200,000 per annum. A copy of the report of the Connecticut Valley Waterway Board, reviewing the expected commerce in more detail, is attached. (Appendix C.) This sum is nearly twice the aggregate of the estimated cost of annual upkeep of the improvement and

interest on the initial improvement at the rate of 4 per cent. No new facts have developed since the submission of the preliminary examination to alter these conclusions. There is no question that the communities affected have a present rail commerce in commodities appropriate for carriage by water exceeding the figure given. On the adjacent lower section of the river from Hartford to the mouth such commodities are actually carried by water despite the lower rail rates there offered. The industrial situation in the section above Hartford is entirely similar, and its commerce has the same markets. With a channel provided as proposed, of the same capacity as that below Hartford, I see no reason for doubting that the expected traffic will be realized in the reach between Hartford and Holyoke, if suitable terminal facilities are provided for the handling of water-borne commerce.

Terminal Facilities.

42. As the waterway in its present condition is entirely inadequate for commercial navigation of any amount, there are no existing terminals for the economical and expeditious handling of freight, and for its storage and distribution. A canvass of the possible sites for such terminals is set forth in the report of the preliminary examination, from which it is apparent that, although especial and somewhat costly means will be required to secure the terminal facilities at the city of Springfield, there are no insuperable difficulties to the establishment of these features at any locality. From one viewpoint the lack of present structures is not without its compensating opportunities. The ground is clear for the adoption of comprehensive and coordinated plans for water-front development. It can not be gainsaid that full advantage should be taken of this opportunity. All experience proves that this advantage can be fully realized and continuously preserved only when the control of the proper frontage is acquired and retained by the municipality or other agency responsible to the citizens of the community. Without proper terminal facilities for handling the commerce, it is obvious that no commensurate benefit will be secured from the large expenditure necessary to improve the waterway for the use of commerce. I believe, therefore, that the United States may properly, and should, assure itself that these facilities will be provided before entering upon this expenditure. As a considerable amount of time must elapse, after the improvement of the waterway is begun, before it has progressed sufficiently to afford the means of commercial navigation, it would be unreasonable to require the completion of the terminals, or even the acquirement by the municipalities of the necessary land and riparian rights, before the work of the United States is commenced. The United States should, however, require that the plans be perfected, enabling legislation enacted, and funds fully provided for the construction of adequate publicly controlled terminal facilities at Holyoke, Chicopee, and Springfield before commencing its own work; and should, further, have proper assurance that the acquirement of the lands and rights and the erection of the structures will be prosecuted contemporaneously with

the improvement of the channel. That the general interest may be duly conserved and protected, the decision of the adequacy of the plans for the terminal improvements and of the sufficiency of the means for putting these plans under execution should rest with the Secretary of War.

Cooperation.

43. In a recent report of a board appointed by the State of Massachusetts to investigate the improvement of the Connecticut River, and designated the Connecticut Valley Waterway Board, it was recommended that the State of Massachusetts, if necessary, should cooperate with the cities and towns of that section of the Commonwealth by making sufficient appropriations for defraying a part of the cost of doing such work as may be required by plans and projects which may be adopted by the Federal Government for providing ample facilities for navigation. The Board of Harbor and Land Commissioners of Massachusetts inform me, in a letter attached, that no definite plan of cooperation has been decided upon. I conceive it to be one of the functions of the present report to suggest and recommend a distribution of the cost of improvement which will be equitable in view of the benefits conferred. It is most evident that especial benefit will be conferred on the cities and towns bordering the river in the States of Massachusetts and Connecticut. Those in Connecticut are of relative small size. Their interest in navigation, though proportionately the same as the interest of the communities in Massachusetts, is not of such actual magnitude as to give ground for belief that active cooperation is to be anticipated from the State of Connecticut or local interests therein. By far the greater portion of the expenditure must, however, be made for works within the borders of Connecticut. But little work, comparatively, is necessary within the State of Massachusetts. Indeed, of the gross total estimated cost, but $125,000, or about 7 per cent of the whole, is for work in that State. While, again, especial benefit in cheaper rates will accrue to the communities immediately affected, the conduct of the actual business of transportation may very likely be in large part prosecuted from New York, and the profits of transportation accrue to citizens of that State. I am constrained to the opinion, therefore, that it is but equitable that the General Government bear the entire cost of the interstate improvement of the main river channel, and that the cooperation of the State and of local interests be directed to the construction of municipally controlled terminals, branch channels thereto, and harbor basins, and other local facilities for navigation, the cost of which, if adequately executed, will be in no inconsiderable ratio to the cost of the main channel. The fact need not be overlooked that a necessary consequence of the improvement will be the alteration of a considerable number of bridges, which would in their present condition, unreasonably obstruct navigation of the character suitable for the improved river. Under the law, the cost of these alterations will be borne by local interests.

44. While the cost of the proposed improvement is great, the resulting

benefits are, I believe, fully commensurate with the expenditure. It is my opinion, therefore, that the Connecticut River, between Hartford and Holyoke, is worthy of comprehensive improvement by the United States, under a project providing for a channel 12 feet in depth at mean low water, and generally 100 feet wide, to be obtained by the construction of a lock and dam at Hartford, and by channel excavation, with regulating works of limited extent, at a total estimated cost, for first construction, of $1,870,000 (if and when a lock and dam are constructed by private interests at the Enfield Rapids), and at an estimated annual cost of $45,000 for the maintenance of the channels, and $20,000 for the operation of the locks and dam. If a lock and dam at the Enfield Rapids are not constructed within a reasonable time by private interest, it is my further recommendation that they be constructed by the United States, at a further cost of $2.080,000, and that the privilege of developing the incident power be leased. I recommend, however, that the necessary appropriation be made subject to the provision that no work be done by the United States upon the project until the Secretary of War is satisfied that suitable and adequate terminal facilities, under municipal or other public control, will be provided at the cities of Springfield, Holyoke, and Chicopee, by the time that the project is completed.

45. If the project be adopted by Congress, the work should be prosecuted at a rate sufficient to insure its entire completion in five years. The construction of the Hartford Lock and Dam must precede all other work, and should be covered by a single contract. To these ends it is necessary that the initial appropriation be $520,000, with authority to enter into contracts to an additional sum of $300,000. Subsequent appropriations, after meeting the contract authorization, should be $350,000 yearly for three years. If the lock and dam at Enfield Rapids be constructed by the United States, the work should be covered by a first appropriation of $1,080,000, and contracts for the additional sum of $1,000,000 should be authorized, the funds to meet which should be appropriated during the following year.

G. B. Pillsbury,
Major, Corps of Engineers.

The Chief of Engineers, U. S. A., in his report of Nov. 12, 1915, to the Secretary of War, called attention to the report of the Board of Engineers for Rivers and Harbors, dated Sept. 14, 1915, concurring in general with the views of the district officer and the division engineer, and stated that —

5. After due consideration of the above-mentioned report, I concur in general with the views of the district officer, the division engineer, and the Board of Engineers for Rivers and Harbors, and therefore report that the improvement by the United States of the Connecticut River between

Hartford, Conn., and Holyoke, Mass., is deemed advisable to the extent of providing a channel 12 feet deep at mean low water and 100 feet wide, under the plans proposed by the district officer (subject to such modifications as may appear advisable during construction), at an estimated cost of $1,870,000 for first construction and $65,000 annually thereafter for maintenance, subject to the following conditions:

(*a*) That water power or other interests will construct a new lock and dam at Enfield in accordance with the plans proposed by the district officer or such other modified plans as may be approved by the Chief of Engineers and the Secretary of War, under the general provision of law applicable to such cases;

(*b*) That the lock and such adjacent land as may be needed for its operation and care shall be deeded without cost to the United States, and sufficient power shall be supplied free of cost for its operation, but that otherwise the lock shall be maintained and operated at the expense of the Federal Government;

(*c*) That those constructing the lock and dam shall assume all responsibility for claims for damages that may arise from flowage rights, from injury to water power, or from any other source; and

(*d*) That the cities of Springfield, Holyoke, and Chicopee shall make suitable provision for terminal facilities satisfactory to the Secretary of War.

The first appropriation should be $520,000, with authority to enter into contracts to an additional sum of $300,000. Subsequent appropriations should be at the rate of $350,000 per year for three years.

DAN C. KINGMAN,
Chief of Engineers, United States Army.

CUTTYHUNK HARBOR.

This harbor was improved by the Commonwealth up to the year 1914 by building two stone jetties at its entrance and by dredging a channel and anchorage basin to a depth of 12 feet at mean low water, and an extension of the channel from the basin into Cuttyhunk Pond, so called, providing a depth of 6 feet at mean low water.

Under a contract entered into July 14, 1914, with John R. Burke, further improvement was provided in response to a petition of the selectmen of the town of Gosnold presented on April 2, 1913. The work accomplished was the dredging of an extension of the existing channel and basin, the channel made 50 feet wide on the bottom, 8 feet deep at mean low water and about 400 feet long, and the basin 100 feet wide on the bottom,

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8 feet deep at mean low water and about 300 feet long. Work was completed Nov. 24, 1914.

On Feb. 23, 1915, hearing was held on a petition of the selectmen of Gosnold, under chapter 481 of the Acts of 1909, for repairs to the jetties at this harbor.

On June 16, 1915, a contract was entered into with Jeremiah P. O'Riorden to widen the channel to this harbor on the northerly side from 30 to 75 feet on the bottom and 12 feet deep at mean low water for a distance of about 1,800 feet; and about 30 feet wide on the bottom and 12 feet deep at mean low water for a distance of about 450 feet on the southerly side. It was estimated that the amount of material to be removed, including the required slopes, was about 18,500 cubic yards, scow measurement. The contract prices were: for widening the channel and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 21 cents for each cubic yard of material excavated, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $5 for each cubic yard.

Work was completed Aug. 12, 1915. On the northerly side of the channel the widening varied from 30 to 75 feet, and on the southerly side the widening was made to about 30 feet. The cost was $4,307.31.

A map of this harbor is printed herewith.

Amount expended during the year, $7,770.31.

Total expenditure to Dec. 1, 1915, $61,472.61.

DEACONS POND HARBOR, FALMOUTH.

Under contracts made in 1908 and 1911 two stone jetties were built at the outer end of the entrance channel to this harbor; a channel from the sound into the harbor dredged to a depth of 7 feet at mean low water, 150 feet wide on the bottom; an anchorage basin dredged to a depth of 7 feet at mean low water; and a shoal 400 feet long and 50 feet wide removed. In 1909 and 1912 additional stone was placed in the westerly jetty.

In 1914 this harbor was further improved under a contract with John R. Burke which provided for dredging, and that the dredged channel be about 625 feet long, 100 feet wide on the bottom and 8 feet deep at mean low water.

In July, 1914, work was completed under a contract with Dennis F. Crowley, which provided for the filling of voids in the stone work of the west jetty with concrete, the building of a concrete cap about 140 feet long on top of the jetty and a concrete wall about 5 feet long on the east jetty; also the construction of a wooden bulkhead about 240 feet long above high-water line east of the east jetty.

On Feb. 23, 1915, hearing was held on a petition of the selectmen of Falmouth, and others, for further improvement of this harbor. An estimate of cost of the work desired was made, plans and specifications prepared, and, a contribution of $2,000 toward the cost of the work having been made by the town of Falmouth, a contract was entered into on April 15, 1915, with the Eastern Dredging Company to dredge a channel and basin; the channel to be 9 feet deep at mean low water and 100 feet wide on the bottom from the 9-foot contour outside the jetties to the southerly line of Clinton Avenue; the basin to be 9 feet deep at mean low water from the channel northeasterly about 900 feet, gradually widening to a width on the bottom of 350 feet with an extension 8 feet deep at mean low water about 400 feet wide on the bottom and about 400 feet long; these dimensions, however, to be decreased or increased at the option of the Board. It was estimated that the amount of material to be removed, including the required slopes, would be about 56,000 cubic yards, scow measurement. The contract prices were: for dredging the channel and basin and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 16.95 cents for each cubic yard of material excavated, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $9.50 for each cubic yard. It was provided in the contract that the cost of the work, including the cost of supervision and incidental expenses, should not exceed $10,000.

Work was completed July 20, 1915, resulting in the dredging of a channel as required by the contract, and the dredging of a basin 9 feet deep at mean low water from the channel northeasterly about 1,300 feet. The basin gradually widens from the channel width to a width of about 350 feet at its upper end. The cost of the work was $9,318.77.

At the outer end of the west jetty at the entrance to this harbor a light as an aid to navigation has been installed by the United States government, and was first in operation Sept. 21, 1914.

A map of this harbor is printed with the report of the Board for 1911.

Amount expended during the year, $10,290.16.

Total expenditure to Dec. 1, 1915, $60,001.03.

Duxbury Bay and Harbor.

In March, 1914, a public hearing was held on petition of the selectmen of Duxbury, and others, for certain dredging, and, after preparing plans and specifications, a contract was entered into on June 30, 1914, with the J. S. Packard Dredging Company to dredge a channel about 1,900 feet long from the 6-foot contour in Duxbury Bay to the pier of the Duxbury Yacht Club; also to dredge an anchorage basin at the Yacht Club pier and a channel about 450 feet long from the anchorage basin to the wharf of the Duxbury Lumber Company, the channels to be 50 feet wide on the bottom and the anchorage basin 200 feet wide on the bottom at the yacht club pier narrowing to a width of 50 feet at the channel, all dredging to be to a depth of 6 feet at mean low water. It was estimated that the amount of material to be removed would be about 37,000 cubic yards, scow measurement. The contract prices are as follows: for dredging channels and anchorage basin and disposing of the dredged material, 32.9 cents per cubic yard of material excavated, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $9 per cubic yard; for dredging channels and anchorage basin and disposing of the dredged material on land and flats, including the construction of suitable dikes and all incidental work, 35 cents per cubic yard of material excavated, measured *in situ*. Work was completed April 16, 1915, at a cost of $12,839.30.

On Aug. 11, 1914, a contract was entered into with the

J. S. Packard Dredging Company to enlarge the anchorage basin, the dredging to be to a depth of 6 feet at mean low water. The amount of material to be removed was estimated to be about 8,000 cubic yards, scow measurement, the contract prices being the same as under the above contract of June 30, 1914. Work was completed May 15, 1915, and consisted of an enlargement of the yacht club basin on the southerly side to a depth of 6 feet at mean low water and an extension of the channel to a connection with the government channel, dredged to a depth of 6 feet at mean low water. The cost was $4,965.30.

Amount expended during the year, $9,830.69.

Total expenditure to Dec. 1, 1915, $19,254.20.

EDGARTOWN HARBOR.

Reference is made to House Document No. 1850 of 1915 for report relating to this harbor.

ESSEX COUNTY BEACHES.

By chapter 85 of the Resolves of 1915 the Board was required to make a survey of the sea beaches in the county of Essex, and to report to the Legislature in 1916 with such recommendations as the Board may deem expedient for regulating the public and private use of said beaches, or any of them, and for the protection of the rights of the public therein. An expenditure of such sums, not exceeding $1,000, as may be approved by the Governor and Council was allowed.

A special report on this matter will be submitted within the time named in the resolve.

FALL RIVER HARBOR.

A detailed statement as to the needs of the harbor of Fall River, together with statistical information and an account of the work undertaken by the Federal government and the appropriations and expenditures therefor, was made in the report of the Board for the year 1913.

On July 2, 1914, chapter 732 of the Acts of 1914, relative to the development of the port of Fall River, was approved, providing for the appointment of a special board to select a site for a public wharf, to secure options of land, and to make plans and a detailed estimate of the cost of procuring the land and of constructing said wharf. A report signed by a majority of the members of this special Board, and a dissenting report, were filed with the Legislature in the early part of 1915. (See House Document No. 1800 of 1915.)

By chapter 279 of the General Acts of 1915 the Board, for the purpose of improving and developing this harbor and the transportation and terminal facilities of the city of Fall River, was authorized to construct piers and do other work to provide for handling freight and receiving passengers, to select a suitable location for the wharf and piers authorized by the act, and authorized to expend on behalf of the Commonwealth for the purposes of the act a sum not exceeding $350,000. Upon the completion of the work authorized the Board is to administer the terminal facilities acquired or created by the Commonwealth under the provisions of the act, the expenses thereof to be determined by the Governor and Council and paid by the Commonwealth, the Board to make rules and regulations and charge such reasonable rates for the use of the structures and equipment as shall be approved by the Governor and Council. The city of Fall River is authorized to take or acquire by purchase or otherwise piers, wharves, buildings, land, flats, rights, privileges, easements and such other land abutting on Mount Hope Bay as the city may deem advisable, and to transfer the same, or such part thereof as the Board may deem necessary, to the Commonwealth without payment therefor, the land so transferred to the Commonwealth to be for the purpose of carrying into effect the provisions of the act. The city, for the purpose of paying the necessary expenses of acquiring land and other property, and for making any contribution necessary toward the work to be done by the Board, is authorized to issue from time to time bonds or notes to an amount not exceeding $250,000. Any unexpended balance of the $250,000 received from the issue of bonds or notes by the city remaining after the payment for land and other property necessary for the site shall be available for the construction of the pier if deemed necessary by the Board, and may be used by it in addition to the $350,000 which the Board is authorized to expend.

In addition to various conferences with officials of the city of Fall River and other parties, the Board held a public hearing at the City Hall in Fall River on June 14, 1915, and learned the views of various parties as to the most desirable location for the construction of a pier. In July, 1915, the Board made personal inspection of the entire water front of the city.

Various sketch plans, studies and estimates of cost for building a pier and other necessary structures and connections at several localities along the water front have been prepared by the Chief Engineer of the Board, but up to Dec. 1, 1915, no conclusive action has been taken with respect to the selection of a site.

Amount expended during the year, $785.69.

Operations by the Federal Government.

Operations and results prior to the fiscal year. — The operations comprised the dredging in the reentrant in front of the wharves immediately north of the Old Colony Steamboat Co.'s Wharf of a channel 160 feet wide, 12 feet deep at mean low water, and 1,500 feet long, with an additional width, same length, of 100 feet and 11 feet deep; a channel 300 feet wide and 25 feet deep at mean low water through Mount Hope Bay and a channel of same dimensions along the city front to connect the deep water in Narragansett Bay with the deep water in the upper portion of the harbor, a total distance of about 4.6 miles; an increase in the 25 feet deep area of the harbor of about 87 acres, all of which has been completed, at a total expenditure of $124,810.51, all of which was for new work.

Operations and results during the fiscal year. — The operations consisted of dredging the greater part of the small shoal areas on the east side of the harbor between the Old Colony Steamboat Co.'s Wharf and Slades Ferry Bridge. This work was done by the Government-owned dredge *Gedney*, and hired labor at a total cost of $15,746.15, all of which was for maintenance.

Condition at the end of fiscal year. — At the end of the fiscal year the general project was 100 per cent completed, but there still remains to be done certain maintenance work. The maximum depth over the shoalest part of the locality under improvement is about 22.4 feet at mean low water. The total expenditure under the existing adopted project was for new work $124,810.51, and for maintenance $15,746.15, a total of $140,556.66. The project was completed for $18,189.49 less than the total estimated cost.

Local cooperation. — None.

Effect of improvement. — The increased depth in the approach channel and in the harbor permits the entrance of larger vessels, but, so far as known, the improvement has had no effect on freight rates.

Proposed operations. — No further estimate is submitted, as the available funds are believed to be sufficient to complete all maintenance work required at present.

FALMOUTH HEIGHTS.

An examination of the wall built by the Commonwealth at Falmouth Heights in 1914, and described in the report of the Board for that year, was made on Dec. 21, 1914, and it was ascertained that a southeasterly storm a few days previous to that date had washed the sand away from the face of the wall exposing the foundation in places, although the wall showed no evidence of settlement or other injury. Subsequently the face of the wall was underpinned for a distance of about 150 feet to prevent the sea from washing the sand from under a portion of the wall during certain conditions of wind and tide. The cost was $393.

Amount expended during the year, $2,785.13.

Total expenditure to Dec. 1, 1915, $5,625.22.

GLOUCESTER HARBOR.

An account of the various surveys, projects and expenditures by the Federal government pertaining to Gloucester Harbor, as well as surveys made and harbor lines established therein by the Commonwealth, was set forth in the report of the Board for 1913, pages 51 to 56.

On April 27, 1915, hearing was held on a petition of Benjamin A. Smith, and others, for dredging a channel in this harbor near Five Pound Island. An estimate of cost was made, plans and specifications prepared, and proposals received on May 26, 1915.

On June 1, 1915, a contract was entered into with the Bay State Dredging Company, Ltd., to dredge a channel and to remove bowlders and ledges above Five Pound Island, the channel to be 100 feet wide on the bottom and 12 feet deep at mean low water from the 12-foot contour north of Five Pound Island easterly about 1,100 feet, except that modifications might be made in the width and length of the area to be dredged in order that the cost of the work, including that of supervision and incidental expenses, should not exceed the sum of $10,000. The contract prices were: for dredging the channel and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 28 cents for each cubic yard of material excavated, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $6 for each cubic yard; for excavating bowlders over 5 cubic yards in volume and ledge, and disposing of the same, $13 for each cubic yard.

Work was completed Oct. 29, 1915, and consisted of the dredging of a channel 50 feet outside the harbor line from deep water northwesterly of Five Pound Island in a northeasterly direction about 1,000 feet, it not being possible to dredge the entire length of channel included in the project and pay for the same with the funds allotted, owing to the amount of ledge and bowlders encountered. The cost of the work was $10,012.53.

A map of this harbor is printed herewith.

Amount expended during the year, $11,743.01.

Total expenditure to Dec. 1, 1915, $12,016.96.

Operations by the Federal Government.

Operations and results during the fiscal year. — Under contract, one ledge in the outer harbor was removed to the depth of 18 feet at mean low water and two ledges in the inner harbor to the depth of 15 feet at mean low water, and work on removal of one of the two remaining ledges in the outer harbor was in progress. The expenditures were $2,837.87 for new work.

Condition at the end of fiscal year. — The project is 83 per cent completed. All the ledges in the inner harbor embraced in the project and all but two in the outer harbor have been removed to the required grades. The removal of these obstructions materially facilitates approach to the water front in the inner harbor and increases the width of the channel in the outer harbor. The expenditures were $7,401.28 for new work.

Effect of improvement. — Freight rates are probably not affected, as the principal industry is fishing, but the work done has resulted in greatly increased facilities for navigation.

Proposed operations. — It is expected that the project will be completed with the available funds. No estimate of additional funds required is therefore submitted.

UNIV. OF MICH.

Annisquam River.

Up to July, 1907, the work done by the Commonwealth comprised the dredging of a channel 50 feet wide and 6 feet deep at mean low water from Gloucester Harbor to Wolf Hill, and the construction of a sea wall on the easterly bank of the new channel. In 1909 the channel from the Boston & Maine Railroad bridge to the Blynman or Cut bridge was dredged and two shoals north of the railroad bridge removed.

Further dredging was done in 1913 and 1914 under a contract with the Eastern Dredging Company, the work consisting of the dredging of a channel 50 feet wide on the bottom and 8 feet deep at mean low water from a point in Gloucester Harbor about 500 feet east of Cut bridge to deep water off Wolf Hill, a total distance of 8,200 feet. The marsh bank on the south side of the channel west of Cut bridge, known as the "canal," was excavated to a slope of 5 to 1 above mean low water. A considerable amount of dredged material was deposited on the land of the city of Gloucester on the northerly side of the canal.

In the later stages of the work ledge was uncovered a short distance west of Cut bridge, which was from 9 inches to 1½ feet shoal over the full width of the channel for a distance of about 200 feet. It was estimated that this would mean the removal of about 360 cubic yards of rock in order to attain the required depth.

On June 23, 1914, a contract was entered into with John Cashman & Sons Company to protect with stone riprap the northerly bank of that portion of the river known as the canal. It was provided that the bank should be graded to the cross-section shown on the plan accompanying the contract for a distance northerly of about 1,300 feet. The contract prices were: for grading bank, including excavation and filling and all work incidental thereto, the lump sum of $1,050; for furnishing and placing stone riprap on the bank and all work incidental thereto, the sum of $1.87 for each ton of 2,000 pounds. Up to Dec. 1, 1914, 75 per cent. of the grading had been completed, and 5,853 tons of stone riprap furnished and placed on the river bank.

In the latter part of November, 1914, the extreme high tides washed out the sand backing through the openings in the riprap, allowing the stone between grade 10 and grade 15 to settle for some distance at the southerly end of the work. It was concluded that no more stone be laid by the contractor above grade 10, or mean high water, until the spring of 1915.

On Dec. 15, 1914, a contract was entered into with the Bay State Dredging Company, Ltd., to remove ledges in this river, estimated to be about 224 cubic yards, to a depth of 8 feet below mean low water. The contract price was $24 per cubic yard, measured in place. All work was completed Sept. 4, 1915, and was carried out under the provisions of chapter 132 of the Resolves of 1914, and an allotment made by the Board, the cost of the work being $5,001.60.

On April 13, 1915, a contract was entered into with John Cashman & Sons Company to take up and relay a portion of the stone riprap previously laid on the northerly bank of the river, covering a total length of about 400 feet. The contract prices were: for use of lighter for taking up riprap, placing new foundations and relaying riprap, $55 per day of nine hours; for chip stone and other extra stone needed to bring slopes to grade, $1.30 per ton of 2,000 pounds. All work was completed June 21, 1915, at a cost of $1,402.20.

On May 18, 1915, a contract was entered into with John Cashman & Sons Company for a continuation of the protection with stone riprap of the northerly bank of this river. The contract prices were: for grading bank, including excavation and filling and all work incidental thereto, $262.50; for furnishing and placing stone riprap on the bank and all work incidental thereto, $1.87 for each ton of 2,000 pounds. All work was completed June 22, 1915, and consisted of the grading of 325 lineal feet of bank and covering the same with riprap. The cost was $1,792.29.

Amount expended during the year, $13,145.95.

Total expenditure to Dec. 1, 1915, $107,245.54.

Mill River.

The tidal portion of Mill River, in Gloucester, a tributary of Annisquam River, extends from the end of Wheeler's Point to the mills at Riverdale, a distance of about 1 mile. At the mouth of the river, before improvement, a bar existed, covered at mean low tide by about 2 feet of water. Above the bar was a narrow winding channel varying in depth from 3 to 6 feet at mean low water.

The project for improvement adopted in 1912 and subsequently carried out was for dredging a channel and anchorage basin to a depth of 6 feet at mean low water, the channel to be 3,400 feet long and 60 feet wide on the bottom, and the anchorage basin to cover an area of about 34,500 square feet. This work, together with the removal of bowlders and ledge, was completed in March, 1913.

By chapter 132 of the Resolves of 1914 the Board was authorized and directed to improve, among other places, Mill River, and to expend for dredging a sum not exceeding $5,000. In 1914 an extension of the channel for a distance of about 900 feet, to a depth of 6 feet at mean low water and a width of 60 feet on the bottom, was dredged.

On May 4, 1915, hearing was held on a petition of James E. Tolman, and others, for further dredging. A contribution of $300 having been made by the city of Gloucester, a contract was entered into on June 9, 1915, with the Bay State Dredging Company, Ltd., to dredge an extension of the channel a distance of about 385 feet to a depth of 6 feet at mean low water and a width of 60 feet on the bottom, it being provided that the cost of the work, including supervision and incidental expenses, should not exceed $3,000. It was estimated that the amount of material to be removed, including the required slopes, would be about 9,500 cubic yards, scow measurement. The contract prices were: for dredging the channel and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 29.5 cents for each cubic yard of material excavated, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $9 per cubic yard.

Work was completed July 27, 1915, and comprised the dredging of a channel from the terminus of the channel dredged in 1914 a further distance of about 325 feet. The cost was $2,867.45.

Amount expended during the year, $4,986.45.

Total expenditure to Dec. 1, 1915, $24,887.67.

HERRING RIVER, HARWICH.

During the year the wooden jetty previously built at this river in West Harwich was repaired, under an agreement with Messrs. Nickerson & Freeman of Harwichport, at a cost of $88.

Under agreements with Richard H. Hefler a bulkhead at this river was repaired at a cost of $134, and 76.7 tons of stone riprap placed in front of it at a cost of $268.45.

Amount expended during the year, $695.07.

Total expenditure to Dec. 1, 1915, $34,293.67.

HYANNIS HARBOR.

No work by the Commonwealth for the improvement of this harbor has been done during the year.

Operations by the Federal Government.

Operations and results prior to the fiscal year. — The operations comprised the building of a stone breakwater 1,170 feet in length and 7 feet above mean low water; the dredging of the 36-acre area north of the breakwater to a depth of 15½ feet at mean low water, increasing the available anchorage area of the harbor by that much; at a total cost, exclusive of the previous project, of $77,790.61, of which $73,950.76 was for new work and $3,839.85 for maintenance. The project had been completed, but some deterioration in depth had taken place.

Operations and results during the fiscal year. — The operations consisted of the completion of the redredging of about 24 acres within the limits of the present project to the project depth, provision for which was made by the river and harbor act of March 4, 1913. This work was prosecuted under the contract in force at the close of the last fiscal year, and was completed November 12, 1914. The total expenditure during the fiscal year was $20,027.45, all of which was for maintenance.

Condition at the end of fiscal year. — The general project is 100 per cent completed. A survey in November, 1914, showed the greater part of the improved area to have the required depth of 15½ feet at mean low water. The harbor now has an anchorage area of about 83 acres protected from southerly storms by a breakwater 1,170 feet long. The total expenditure under the existing project was $97,818.06, of which $73,950.76 was for new work and $23,867.30 for maintenance.

Local cooperation. — None.

Effect of improvement. — So far as known, the improvement has had no effect on freight rates, but the harbor provides shelter for a greater number and a larger class of vessels.

Proposed operations. — Project is completed. No new work is contemplated at this time.

Ipswich River.

A petition of George A. Schofield, and others, under chapter 481 of the Acts of 1909, for completion of the stone jetty on the southwesterly side of the river mouth, which was contracted for by the Commonwealth in April, 1911, and for the dredging of a channel, was presented Jan. 28, 1914, and a public hearing held March 24, 1914.

A contract was entered into on June 30, 1914, with Rendle & Stoddard to build a concrete wall and timber bulkhead on the south side of this jetty, the contract price being the lump sum of $2,324. In November, 1914, heavy storms cut away the shore on the north side of the inshore end of the stone jetty, undermined the stone work and endangered the timber fence recently built under the above contract, making it necessary to place an additional amount of riprap.

Proposals for this additional work were received on Aug. 18, 1915, but no contract was entered into.

The firm of Rendle & Stoddard having failed to complete the work within the time specified in their contract of June 30, 1914, this matter has been taken up with the surety company on the bond accompanying the contract with a view to its adjustment.

On May 4, 1915, hearing was held on a petition of Henry F. Long, under chapter 481 of the Acts of 1909, for further improvement of this river by widening and deepening the channels. It was stated that the town would co-operate by building a public landing for use in connection with the improved channel. Plans, specifications and estimate of cost having been prepared, the work was advertised and proposals received, but the prices obtained were deemed excessive, and on June 23, 1915 all proposals were rejected. Subsequently a new project was prepared, proposals received on July 7, 1915, and on Aug. 10, 1915, a contract entered into with John H. Gerrish to dredge a channel through three shoal places to a depth of 6 feet at mean low water, the bottom width of the sections to be dredged varying from 60 to 75 feet and the length of the same varying from 550 to 1,450 feet. The amount of material to be removed, including the required slopes, was estimated to be about 33,235 cubic yards, scow measurement. The contract prices are: for dredging the channel and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 31.7 cents for each cubic yard of material excavated, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $6 for each cubic yard. Up to Dec. 1, 1915, 3,057 cubic yards have been excavated under this contract.

Amount expended during the year, $1,236.25.

Total expenditure to Dec. 1, 1915, $18,708.86.

LEWIS BAY.

This bay, in the towns of Barnstable and Yarmouth, was surveyed and examined in 1899, under authority of chapter 96 of the resolves of that year. Under contract of May 17, 1900, the channel leading to the wharves in the inner bay was dredged to 6 feet at mean low water, thus providing a width of 150 feet in the upper and of 200 feet in the outer portion.

In 1905 a channel was dredged across the bar in the eastern end of the bay.

A map of this bay is printed with the report of 1899.

By chapter 356 of the Special Acts of 1915 the Board was authorized to make an examination and survey and to dredge a channel or channels and anchorage basin in this bay in such places and to such depths as it may deem necessary. It was further provided that a sum not exceeding $9,000 might be expended for the purpose set forth in the act, provided the town of Barnstable accepted the act, voted to build a public wharf and landing with an approach thereto, and appropriated not less than $1,000 for building such public wharf and landing and an approach thereto. The town at a special town meeting held June 23, 1915, voted to accept this act, and appropriated $1,000.

Plans and specifications for dredging were prepared, and on Sept. 22, 1915, a contract was entered into with John R. Burke to dredge the outer and inner channels and a basin, the outer channel to be 60 feet wide on the bottom, 9 feet deep at mean low water and about 4,700 feet long, the inner channel to be 60 feet wide on the bottom, 6 feet deep at mean low water and about 300 feet long, and the basin to be 200 feet wide and 250 feet long on the bottom and about 6 feet deep at mean low water. The amount of material to be removed, including the required slopes, was estimated to be about 36,000 cubic yards, scow measurement. The contract prices are: for dredging the channels and basin and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 23.4 cents for each cubic yard of material, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $10 for each cubic yard. It was further provided that the cost of the work, including the cost of supervision and incidental expenses, should not exceed $9,000. Up to Dec. 1, 1915, 8 per cent. of the work was completed.

On Oct. 6, 1915, the Board held a public hearing, on the petition of the town of Barnstable, for approval of plans for the public landing authorized by the special act of 1915, aforesaid, and on Oct. 26, 1915, plans were approved and license granted.

Amount expended during the year, $648.69.

Total expenditure to Dec. 1, 1915, $17,660.91.

LYNN HARBOR.

Reference is made to the report of this Board for the year 1913, pages 68 to 77, for a review in detail of legislation, reports of the Harbor and Land Commissioners and special commissions concerning this harbor, various plans and projects for its improvement prepared by the Federal government, statistical data, and appropriations made by Congress and expenditures for carrying projects into effect.

The work of dredging an anchorage basin, under contract of May 28, 1913, with Jeremiah P. O'Riorden, which was set forth in the report of the Board for 1914, was completed Aug. 7, 1914.

By chapter 291 of the General Acts of 1915 the Board was authorized to enlarge this anchorage basin and to deposit the dredged material on certain land and flats in this harbor belonging to the Commonwealth and now under the control of the Metropolitan Park Commission and within a bulkhead now built or within an extension thereof. Authority was given to expend for dredging and depositing the dredged material a sum not exceeding $25,000 from the treasury of the Commonwealth, provided that there is available an additional sum of $5,000 to be appropriated by the city of Lynn, and that of the amount to be paid from the treasury of the Commonwealth $15,000 shall be paid from the ordinary revenue and the remaining $10,000 paid from the Metropolitan Park Commission's maintenance fund.

On July 21, 1915, a contract was entered into with the J. S. Packard Dredging Company to enlarge this basin and to deposit the dredged material as required by the above act, dredging to be done to a depth of 6 feet at mean low water over an area of about 445,000 square feet, and the dredged material to be deposited to an elevation of 15 feet above mean low water. The amount of material to be removed from the anchorage basin, including the required slopes, was estimated to be about 117,000 cubic yards, *situ* or scow measurement. The contract price is: for dredging the basin and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, within the bulkhead built by the Metropolitan Park Commission on the Nahant shore, or against the outer face of said bulkhead, or in the earth dike or other structure to be built at the northerly end of the area to be filled, including the construction of a sod dike or timber structure, the rehandling of the material from scows, grading and all incidental work, the sum of $30,000. Up to Dec. 1, 1915, about 12 per cent. of the work was completed.

Amount expended during the year, $135.71.

Total expenditure to Dec. 1, 1915, $37,088.92.

Operations by the Federal Government.

Operations and results prior to the fiscal year. — By dredging a channel from the sea to the wharves 300 feet wide and 15 feet deep at mean low water and a turning basin at the inner end of the same depth and 500 feet square had been obtained. The western (Saugus River) channel in Lynn Harbor had been dredged to a depth of 8 feet at mean low water and 150 feet wide, for an aggregate length of 2,200 feet. The expenditures under the present project were $125,792.53 for original work.

Operations and results during the fiscal year. — A survey by day labor developed the necessity of some redredging in the inner channel and basin. The expenditures were $694.21, for maintenance.

Condition at the end of fiscal year. — The approved project was completed September 8, 1913. The outer channel is in good condition and the inner channel and basin have full continuous depth of 15 feet at mean low water but are contracted in width by shoaling. The shoalest depth found on a recent examination was 12 feet at mean low water, but the material is soft and does not seriously obstruct navigation at present. Steps will be taken later to remove these shoals. The expenditures were $125,792.53 for new work (which completed the project at a saving of $53,207.47) and $694.21 for maintenance, a total of $126,486.74.

Local cooperation. — No conditions have been imposed by law. The Commonwealth of Massachusetts has dredged immediately east of the Government channel an anchorage basin to the depth of 6 feet at mean low water, at a cost of $36,953.21, and is dredging a channel 12 feet deep at mean low water from Broad Sound up Saugus River to the Lynn works of the General Electric Co., opposite which it is 18 feet deep at mean low water, thence continuing 6 feet deep at mean low water to Fox Hill Bridge. A large portion of the material is being pumped ashore to make land on the northerly side of the channel easterly of Lynn Boulevard. This channel through Broad Sound supersedes the 8-foot channel dredged by the United States.

Effect of improvement. — The deepening of the channel to 15 feet enables the smaller barges to carry full cargoes of coal to the wharves at all stages of the tide and barges of the greatest draft during the higher stages. It is reported by local commercial interests that the cost of transportation was reduced 25 cents a ton by deepening the channel to 10 feet and further diminished by increasing the depth to 15 feet.

Proposed operations. — The project being completed and the unexpended funds being sufficient for any necessary maintenance of the channel, no estimate of additional funds required is submitted.

The River and Harbor Act approved March 4, 1915, authorizes and directs the Secretary of War to cause a preliminary examination and survey to be made of Lynn Harbor. Up to Dec. 1, 1915, a copy of the preliminary report was not available.

LYNN HARBOR AND SAUGUS RIVER.

By chapter 741 of the Acts of 1914 the Board was authorized to improve Lynn Harbor and Saugus River by dredging a channel not less than 12 feet in depth at mean low water from the present 12-foot contour southerly of the Point of Pines to the Boston & Maine Railroad bridge across Saugus River, and by dredging said river between the Boston & Maine Railroad bridge and Fox Hill bridge, so called. The Board was authorized to expend for dredging a sum not exceeding $50,000, provided that no part of this sum should be available or expended until evidence was presented to the Auditor of the Commonwealth that there was available the additional sum of $30,000, of which one-half should be appropriated by the city of Lynn for the building of bulkheads and the reclamation of flats owned by said city bordering on said river, and the balance, $15,000, for dredging said river between the Boston & Maine Railroad bridge and Fox Hill bridge and for reclamation of certain flats, to be contributed by other parties. A further provision of the act was that the city should be allowed to use the material dredged under authority of the act for the purpose of reclaiming certain flats.

On Oct. 6, 1914, a contract was entered into with the Eastern Dredging Company, involving an expenditure of not exceeding $95,000, the $15,000 in excess of the amount provided for in the act of 1914 aforesaid being made up by an allotment of $10,000 from the funds at the disposal of the Board under authority of chapter 481 of the Acts of 1909, and an additional appropriation of $5,000 by the city of Lynn. A description of the work covered by this contract, including the contract prices to be paid, is set forth in the report of the Board for 1914, pages 40 to 42.

Work under this contract commenced in October, 1914, and up to Dec. 1, 1915, approximately 75 per cent. was completed.

A map of this harbor is printed herewith.

Amount expended during the year, $60,471.96.

Total expenditure to Dec. 1, 1915, $60,954.09.

MANCHESTER HARBOR.

No work has been done by the Board in this harbor during the year 1915.

The River and Harbor Act approved March 4, 1915, authorizes and directs the Secretary of War to cause a preliminary examination and survey to be made of this harbor with a

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view to straightening the channel by the removal of Bow Bell Ledge. Up to Dec. 1, 1915, a copy of the preliminary report was not available.

Total expenditure by the Commonwealth to Dec. 1, 1915, $81,706.40.

MENAMSHA INLET.

On March 5, 1914, a petition of Henry H. Allen, and others, under chapter 481 of the Acts of 1909, for further improvement and for repair work at Menamsha Inlet, in Gay Head and Chilmark, was received, and a hearing held on March 24, 1914. Statements were made that the basin is shoaling and requires further dredging; that the jetties need repairs; that the bulkhead reinforced last year by the Board needs further strengthening; that the beach in this locality has been washed by the winter storms.

Plans and specifications having been prepared and an estimate made of the approximate cost of the work, a contract was entered into on May 12, 1915, with Dennis F. Crowley to construct a concrete sea wall with spur jetties on the beach at the east side of the entrance to this Inlet, the wall to extend from the easterly jetty near the inshore end easterly along the crest of the beach about 460 feet, the spur jetties to be 8 in number on the east side of the wall, with anchor rods into the wall. The contract prices were: for furnishing the materials and building the concrete sea wall and spur jetties, including the cost of anchor rods, excavation, back filling, disposal of surplus material, furnishing, erecting and removing forms, and all incidental work, $6.40 for each cubic yard of concrete measured in place in the completed work.

Work was completed Aug. 26, 1915. The wall is 398.48 feet in length with 9 spur jetties and a short section of cross wall at the northerly end, connecting the main wall with a high mound of sand to prevent the sea from getting back of the wall. Certain grading was done in connection with the work covered by the contract. The cost of the work was $2,781.27.

On June 1, 1915, a contract was entered into with John R. Burke to dredge an extension of the basin on the east side of the channel and to remove a shoal in the channel, the basin to be 5 feet deep at mean low water and the shoal in the channel to be removed to the same depth. The amount of material to be removed was estimated to be about 8,000 cubic yards. The contract prices were: for dredging the basin and channel and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 38.7 cents for each cubic yard, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $5 for each cubic yard.

Work was completed Oct. 14, 1915, the cost being $3,100.64.

Amount expended during the year, $5,913.61.

Total expenditure to Dec. 1, 1915, $63,544.09.

MERRIMAC RIVER.

The report of the Board for the year 1913 contained an account of the surveys and projects of the Federal government for the improvement of Merrimac River, and the conclusion and recommendations of the Merrimac Valley Waterway Board, — a special commission appointed under the provisions of chapter 708 of the Acts of 1912 to make an investigation of this river, — including a survey and study of the possibilities of development of navigation and power.

This was followed by the passage of chapter 691 of the Acts of 1914, which authorizes the expenditure, under the direction of the Harbor and Land Commissioners, of not exceeding $1,000,000 for the improvement for navigation of this river from the sea to Lowell by the construction of a channel therein: "*provided,* that no part of said sum shall be available or expended until the congress of the United States shall approve a project, and make an appropriation therefor, to improve that part of said river from the sea to a point opposite Ward's hill about one mile above Haverhill, so that a continuous channel will be provided throughout this part of said river not less than eighteen feet deep at mean low water and of adequate width."

In November, 1914, a report of the United States Engineer Officer stationed at Boston, on his survey of this river with a view to securing increased depth from Lowell to the sea or in any part of this section of the river, together with estimate of cost, was submitted to the Chief of Engineers.

This report was unfavorable to the undertaking of the improvements by the Federal government because of the large cost involved and the uncertainty of resultant benefits commensurate with so large an expenditure; also because of the possible effect upon the improvement of the river at the mouth by the restriction of tidal scour if a dam should be built, and the possible disadvantages arising from the consequent ponding of water containing sewage.

At the request of persons interested in this matter the report was referred back to the district engineer officer, in order that opportunity might be given for the submitting of further evidence in regard to the necessity for this improvement and its economic value.

In response to a request from the Board a statement was received from Col. William E. Craighill, Corps of Engineers, U. S. A., in part as follows: —

> My report of November 10, 1914, upon the survey of Merrimac River, was returned to me by the Chief of Engineers on December 14, 1914, with the statement that it had been represented to the Chief of Engineers that parties interested in the improvement of Merrimac River had substantial additional facts tending to prove the advisability of improving the river. I was instructed to give such time as they might desire to submit additional data, provided that the resubmission of the report should be delayed not later than November 1, 1915. Pursuant to those instructions, a public hearing was held at the City Hall, Lawrence, April 15, 1915, and subsequently various conferences were held at this office with persons interested in the improvement.
>
> After careful consideration I submitted final report upon the matter under date of October 22, 1915, my conclusions being that the benefits to be expected are so uncertain, and the physical difficulties, and consequently the cost, are so great that the improvement should not be undertaken by the United States.

During the year the Board authorized the placing of monuments to mark points in the harbor line of this river established by chapter 506 of the Acts of 1914.

Amount expended during the year, $555.06.

Total expenditure to Dec. 1, 1915, $562.05.

The River and Harbor Act, approved March 4, 1915, authorizes and directs the Secretary of War to cause a preliminary examination and survey to be made of Merrimac River from Lowell, Mass., to Manchester, N. H. Up to Dec. 1, 1915, a copy of the preliminary report was not available.

Operations by the Federal Government.

Operations and results during the fiscal year. — Under contract a stretch of channel extending about 1,500 feet upstream from Rocks Bridge was redredged, completing the restoration of the entire channel to the projected dimensions. The expenditure was $6,317.57, all for maintenance.

Condition at the end of fiscal year. — The approved project was completed in December, 1907. The channel from Newburyport to Haverhill is now 150 feet wide and 7 feet deep at mean low water. The expenditures were $115,424.77 for new work (which completed the project at a saving of $56,017.93) and for maintenance, $34,377.31, a total of $149,802.08.

Local cooperation. — None.

Effect of improvement. — The improvement of the channel is reported to enable the delivery of coal by water at rates 35 to 50 cents per ton less than by rail.

Proposed operations. — The restoration of the channel to its full projected dimensions was completed in August, 1914. From past records it may be expected that by 1917 maintenance dredging will again be necessary, for which it is estimated that $10,000 will be required.

Commercial statistics. — The commerce of the river during the current year consisted chiefly of coal distributed to the cities and towns along its banks.

NANTUCKET HARBOR.

No work by the Commonwealth for the improvement of this harbor has been done during the year.

Operations by the Federal Government.

Operations and results during the fiscal year. — The operations comprised dredging only. The channel between the jetties was increased in width about 50 feet for its full length, 1.4 miles, and some shoals which had formed in the previously dredged area were removed, making the present width of channel about 300 feet and 15 feet deep at mean low water. An additional width of 150 feet and same length was partially dredged, over the greater part of which there is a depth of 12 feet. This work was done by contract and completed September 5, 1914, at a total cost of $38,674.59, of which $29,005.94 was for new work and $9,668.65 for maintenance.

Condition at the end of fiscal year. — At the close of the fiscal year about

95 per cent of the original project was completed, the result of which is a channel 300 feet wide and 15 feet deep at mean low water from the deep water in Nantucket Sound to the deep water in Nantucket Harbor, a distance of 1.4 miles, with an additional width of 150 feet, over the greater part of which there is a 12-foot depth. The total expenditure under the existing adopted project was $523,037.20, of which $426,595.70 was for new work and $96,441.50 for maintenance.

Local cooperation. — None.

Effect of improvement. — So far as known the project has had no effect on freight rates, but the widening and deepening of the channel gives the use of the harbor to vessels of larger size.

Proposed operations. — It is proposed to apply the funds asked for to the restoration of the jetties to original cross section, which was disturbed by ice and storms, as shown on survey of August, 1914, and the extension of the west jetty and dredging harbor entrance channel.

NEWBURYPORT HARBOR.

No work by the Commonwealth for the improvement of this harbor has been done during the year.

Operations by the Federal Government.

Operations and results during the fiscal year. — Under contract, the outer 1,250 feet of the north jetty was completed to the full projected cross section. The expenditures were $20,263.55 for new work and $15.44 for maintenance, a total of $20,278.99.

Condition at the end of fiscal year. — The project is about 97 per cent completed. The construction of the jetties has increased the depth so that under favorable conditions about 12 feet draft can be carried over the bar at mean low water, but the usual draft is 9 feet and this draft can be carried to the wharves at Newburyport, alongside some of which there is a depth of 12 to 15 feet at low water. There was expended for new work $463,843.62 and for maintenance $10,405.12, a total of $474,248.74.

Local cooperation. — None.

Effect of improvement. — It is reported that the improvement made has reduced freight rates 25 cents per ton, and that if the projected depth of 17 feet at mean low water be obtained over the outer bar it would still further reduce the freight rates 15 to 25 cents per ton.

Proposed operations. — Due to settlement on account of storm seas both jetties require retopping in places, which it is estimated will require about 16,000 tons of stone at $1.25 per ton, $20,000.

Commercial stotistics. — The commerce during the current year was chiefly coal, about 48 per cent of which was reshipped to points on the Merrimac and Powow Rivers.

NEW BEDFORD AND FAIRHAVEN HARBORS.

State Pier.

By chapter 693 of the Acts of 1914 the Board was authorized to reconstruct and extend the present southerly pier owned by the city of New Bedford and to reconstruct the pier adjoining the same on the north; to build sheds or other buildings on said piers, and to provide the necessary equipment and appliances for handling freight and receiving passengers; to also fill solid and dredge and to do such other work as might be necessary to carry out the purposes of the act for the improvement of the harbor and terminal facilities of the city of New Bedford.

A new harbor line having been established in this locality by chapter 378 of the Acts of 1914, plans were prepared by the Chief Engineer of the Board and its regular engineering force for the construction, within the appropriation of $350,000, of a single pier which, with the berth on each side, will occupy the space now covered by the two piers referred to in the act; but a careful study of the situation showed that this was unavoidable if a pier was to be provided with adequate facilities and ample berth room to meet requirements of modern commerce.

Proposals were invited for the construction of the pier and shed, on both a solid-fill and open-pier type of design, and under date of Jan. 5, 1915, a contract was entered into with the W. H. Ellis & Son Company to carry into effect the work called for in the plans and specifications, involving an expenditure of approximately $316,872. A plan of the pier to be built is printed with the report of the Board for 1914 and a description of the work to be done is contained therein. Up to Dec. 1, 1915, 35 per cent. of the work had been completed.

Amount expended during the year, $117,515.75.

Total expenditure to Dec. 1, 1915, $118,283.79.

Operations by the Federal Government.

Operations and results prior to the fiscal year. — The 300-foot channel from Buzzards Bay to the north end of Fish Island has been dredged to 25 feet at mean low water, except close to the New Bedford and Fairhaven Bridge, where it is but 18 feet deep, owing to the crossing of a city-water pipe. The turning basin north of the New Bedford and Fairhaven Bridge and the anchorage area between New Bedford and Fairhaven have been completed, with the exception of a narrow strip about 40 feet wide along the southwest side of the anchorage area and a small area of ledge rock at the north end of Palmers Island. The short channel between New Bedford and Fish Island authorized by the river and harbor act, March 3, 1909, has not been dredged because the work could not be done within the limits of cost as prescribed. The total amount expended was $524,092.45, all of which was for new work.

Operations and results during the fiscal year. — No works of improvement have been in progress during the fiscal year. The total expenditure was $2,000.07, all of which was for maintenance.

Condition at the end of fiscal year. — At the close of the fiscal year about 91 per cent of the general project had been completed. The main channel, 300 feet wide and 2.9 miles long, extending from the deep water in Buzzards Bay to just above the New Bedford and Fairhaven Bridge, a turning basin 600 feet by 900 feet above the bridge, and an anchorage of 114 acres between New Bedford and Fairhaven have been dredged to 25 feet at mean low water, with the exception of a strip about 40 feet wide along the southwest side of the anchorage area, the ledge of rock at the north end of Palmers Island, and a ridge across the main channel close to the bridge in which is a city water pipe. There is now a navigable depth of 25 feet from the bay to the city. The total amount expended under the existing adopted project was $526,092.52 of which $524,092.45 was for new work and $2,000.07 for maintenance.

Local cooperation. — The modification of the existing project authorized by river and harbor act of July 25, 1912, imposed the condition that local interests construct a new bridge at Coggeshall Street with a draw opening of at least 100 feet and build a substantial wharf upon the city property at Belleville, the name given to the northern part of the city. These conditions have not been met and there is no present prospect of their being complied with.

Effect of improvement. — The effect of the deep water on commerce is the use of deeper draft vessels and larger cargoes. So far as known the improvement has had no effect on freight rates.

Proposed operations. — It is proposed to apply the funds asked for to maintenance dredging of completed channels and anchorage.

NOBSCUSSET HARBOR, DENNIS.

On Feb. 4, 1914, a petition of Richard H. Hefler, under chapter 481 of the Acts of 1909, for the construction of a breakwater in Barnstable Bay at Nobscusset Point in the town of Dennis, was presented, and a hearing held on March 3, 1914.

An examination was made of this locality, plans and specifications prepared, and proposals received July 14, 1914. On Aug. 11, 1914, a contract was entered into with William H. Connor for building a pile and timber breakwater. Work was completed Nov. 24, 1915, at a cost of $7,185.27. This breakwater extends from high water on the point of land known as Nobscusset Point in an easterly direction 336.5 feet, thence in a southeasterly direction 479.5 feet, about parallel with the shore. An extension about 18 feet long was built above high water on the inshore end and faced with riprap to prevent high tides from cutting into the bank around the end of the breakwater.

Early in 1915, under agreements with Dennis F. Crowley, stone riprap was placed at Nobscusset Point and the existing earth dike repaired. At $1.75 per ton riprap protection was provided for a distance of 221 feet at a cost of $733.25. Subsequently 280 lineal feet of dike was built to repair the existing dike, at a price of $1 per cubic yard of earth in place in the dike and $1 per ton for small stone in front of the same, at a cost of $357.

By chapter 351 of the Special Acts of 1915 the Board was authorized to make a survey and examination and to dredge a channel and anchorage basin in the harbor in the vicinity of Old Corporation Wharf, so called, in the town of Dennis, in such locations and to such depths as it might deem necessary and advisable. It was further provided that the Board might expend for the examination and survey and for dredging a sum not exceeding $10,000, provided the town of Dennis accepted the act and voted to build a public wharf and landing and an approach thereto. The town at a special meeting held June 26, 1915, voted to accept this act and appropriated $500 for building a public wharf and landing and an approach thereto.

Plans and specifications for dredging were prepared and proposals for the same received on July 28, 1915. A contract with John H. Gerrish, under date of Aug. 4, 1915, was subsequently entered into for dredging a channel and basin, the channel to extend from the 6-foot contour in Cape Cod Bay southwesterly about 800 feet to a proposed basin near the town landing, and to be 50 feet wide on the bottom and 6 feet deep at mean low water, the basin to be about 100 feet wide, and 300 feet long on the bottom and 6 feet deep at mean low water. The amount of material to be removed, including the required slopes, was estimated to be about 50,000 cubic yards, scow measurement. The contract prices were: for dredging the channel and basin and disposing of the dredged material including bowlders 1 cubic yard or less in volume, 18.3 cents for each cubic yard of material, measured in scows or *in situ;* for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $8 for each cubic yard. Up to Dec. 1, 1915, work had not been commenced.

On Sept. 8, 1915, a hearing was held on a petition of the selectmen of Dennis for approval of plans for a public landing, authorized by the special act of 1915, aforesaid, and on Oct. 26, 1915, plans were approved and a license granted.

On Sept. 15, 1915, a contract was entered into with Dennis F. Crowley to remove stones and bowlders within the proposed channel and basin and place the same against the timber breakwater on the outside of the basin. The contract price was: for removing not less than 250 tons of stone and bowlders and placing the same against the timber breakwater, the sum of $500.

On Sept. 15, 1915, a contract was entered into with Dennis F. Crowley for furnishing and placing stone on both sides of the timber breakwater. The contract prices were: for raising and straightening inshore portion of breakwater, the sum of $150; for furnishing and placing granite quarry grout, $3 for each ton of 2,000 pounds in place; for removing and placing bowlders from the beach, the sum of $2 for each ton of 2,000 pounds in place; for mattress of brush in place, the sum of $100. This work was completed Nov. 6, 1915, at a cost of $5,964.

Amount expended during the year, $3,952.25.

Total expenditure to Dec. 1, 1915, $4,034.62.

NORTH RIVER, SCITUATE.

Reference is made to House Document No. 1850 of 1915 for report of the Board relating to this river.

Onset Bay.

The River and Harbor Act, approved March 4, 1915, authorizes and directs the Secretary of War to cause a preliminary examination and survey to be made of Onset Bay for the deepening and widening of the existing channel from Onset to the vicinity of Wickets Island, for the construction of an anchorage basin in Onset Bay, and for the construction of a channel between Wickets Island and Onset Island to the Cape Cod Canal channel above Monument Beach. Up to Dec. 1, 1915, a copy of the preliminary report was not available.

Pamet River, Truro.

The improvement of this river, petitioned for under chapter 481 of the Acts of 1909, referred to in the report of the Board for 1913, has been further considered this year, but involves a larger allotment than is possible from the funds at the disposal of the Board.

Paskamansett River.

The Board, basing its action on a petition of the selectmen of Dartmouth, and others, under chapter 481 of the Acts of 1909, directed that a survey and estimate of the cost of improving the mouth of this river be made, and later voted to set aside $2,500 for the work. A project for the construction of a pile and timber jetty was prepared, and on Dec. 15, 1914, the Board entered into a contract with Frank C. Taylor to build this jetty. The contract price for furnishing materials and building the jetty, and all incidental work connected therewith, was $11 per linear foot of jetty in place. Work was completed Feb. 27, 1915, and consisted of the construction of 252 linear feet of jetty about 500 feet southeasterly from Deep Water Point at the entrance to the river. The cost was $2,772.

Amount expended during the year, $2,926.34.

Total expenditure to Dec. 1, 1915, $5,227.68.

Plymouth Harbor.

An account of the work done by the Commonwealth for the improvement of this harbor, with statement as to the various projects, appropriations and expenditures of the Federal government for said harbor, is given in the report of this Board for the year 1913.

A project of the United States under the River and Harbor Act of March 4, 1913, provided for the improvement of the harbor by dredging a channel 18 feet deep at mean low water from that depth in the bay to the town wharves, about 200 feet wide, increased at the entrance and on curves, at a total estimated cost of $167,000. By this act Congress appropriated $83,500 for carrying out this project, expenditure of this amount being conditioned upon the defraying of the remaining half of the expense by the Commonwealth of Massachusetts or other interests. In June, 1913, by chapter 132 of the Resolves of 1913, the Commonwealth appropriated $83,500 to be used in connection with the appropriation by Congress for the improvement of this harbor. This sum was accordingly paid by the State Treasurer to the Secretary of War by check dated Aug. 14, 1913.

On Feb. 28, 1914, a contract was entered into between the United States and Eugene Breymann for dredging in this harbor under the provisions of the act of 1913 aforesaid. The Board is informed that the work was completed Sept. 18, 1915, and that the total cost was approximately $114,000.

One-half of this cost being $57,000, it will be seen that the Commonwealth, in appropriating and paying to the Secretary of War $83,500, has paid $26,500 in excess of one-half of the actual cost of the work. This Board had no duty to perform with reference to the expenditure of this contribution of $83,500 made by the State, but has suggested to the State Auditor that application be made to the Secretary of War for the refunding of this excess amount, $26,500, to the Commonwealth.

It is recommended that when this amount is received by the Commonwealth the Board be authorized to expend the same, in its discretion, for such river and harbor work as it may deem advisable. This recommendation has been embodied in a draft of a resolve submitted.

On May 25, 1915, a petition was received from the Plymouth Yacht Club for the dredging by the Commonwealth of an anchorage basin for yachts in this harbor. Plans and specifications were prepared and the work advertised. On June 30, 1915, proposals were received but were subsequently rejected as they were deemed excessive. A contribution of $500 having been received from the town of Plymouth, the Board on Aug. 4, 1915, entered into a contract with the Eastern Dredging Company to dredge a basin in this harbor extending northerly from the government channel and easterly of Long, North and Craig wharves, to be 12 feet deep at mean low water and to have an area of about 100,000 square feet. The contract prices were: for dredging the basin and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 14 cents for each cubic yard of material excavated, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $9.50 per cubic yard. It was estimated that the amount of material to be removed, including slopes, was about 50,000 cubic yards, scow measurement. Work was completed Oct. 16, 1915, a basin covering an area of about 94,000 square feet being dredged to the depth required by the contract. The cost was $7,000.

Amount expended during the year, $6,897.92.

Total expenditure to Dec. 1, 1915, $234,143.53.

Operations by the Federal Government.

Operations and results prior to the fiscal year. — Under the beach protection projects various sand-catching devices of timber had been built but have long since washed away; several miles of rubblestone dike had been built, which resulted in strengthening the beach by the accretion of a large volume of sand and shingle; Eel River had been restored to its former course, and the place where it had cut through to the sea was also protected with a stone dike. By dredging, a channel 150 feet wide and 9 feet deep at mean low water had been obtained to the town wharves, including a turning basin; and a new channel, 18 feet deep, which is located on the site of the old one and supersedes it, had been 20 per cent completed. The expenditures under the present project for beach protection were $81,376.28 for new work and $18,800 for maintenance. The expenditures under the present project for dredging were $9,291.41 for new work, making the total expenditures $109,467.69, of which $90,667.69 was for new work and $18,800 for maintenance.

Operations and results during the fiscal year. — No operations were in progress and no expenditures made, except for dredging the 18-foot channel, which was practically completed, and in the turning basin. The expenditures were $86,758.25, all for new work, under contract.

Condition at the end of fiscal year. — The condition of the work under the present project for beach protection is as stated under *Operations and results prior to the fiscal year*. The protection as at present constructed is sufficient, but from the nature of the work it can at no time be considered completed. The expenditures were $81,376.28 for new work and $18,800 for maintenance.

Local cooperation. — The act of March 4, 1913, adopting the project for the 18-foot channel appropriated one-half ($83,500) of its total estimated cost, subject to the condition that the Commonwealth of Massachusetts or other local agency contribute a like amount. This condition was accepted by the Commonwealth.

The town of Plymouth, in 1909, at an expense of $12,000, restored and deepened to 10 feet at mean low water the channel and a portion of the basin completed by the Government under the project of 1875. In 1911, with funds provided by the Commonwealth of Massachusetts and the town of Plymouth, the Commonwealth dredged a channel to the wharf of the Plymouth Cordage Co., for a length of about 1,100 feet to the width of 250 feet and depth of 20 feet at mean low water and for a length of about 5,000 feet to the width of 150 feet and depth of 18 feet at mean low water, at a total cost of $142,339.09.

Effect of improvement. — It is reported by the harbor master at Plymouth that the old 9-foot channel effected a saving of 50 cents per ton in freight rates. No data are yet available as to the effect of the deeper channel.

Proposed operations. — No estimate of additional funds required is submitted for the reason that the available funds are sufficient.

PROVINCETOWN HARBOR.

Reference is made to House Document No. 1850 of 1915 for report relating to this harbor.

Operations by the Federal Government.

Operations and results prior to the fiscal year. — Rubblestone beach protection has been built on the east and outside of Long Point; and timber structures of temporary character designed to catch and hold the sand had been built at various other places, but without success as a permanent improvement. A dike across House Point Island flats had been built. The expenditures under the present project were $118,331.49 for original work.

Operations and results during the fiscal year. — No operations were in progress. The expenditures were $13,337.63 for final payment on contract ($12,728.63 for the dike and $609 for repair of beach protection at Long Point) and $593.16 for engineering expenses, chargeable $13,321.79 to new work and $609 to maintenance, a total of $13,930.79.

Condition at the end of fiscal year. — The approved project was completed June 26, 1914, with the exception of the extension of the beach protection at Long Point, which is not now considered necessary. The expenditures for new work were $131,653.28 (which completed the dike at a saving of $4,846.72) and $609 for maintenance, a total of $132,262.28.

Local cooperation. — None.

Effect of improvement. — The object of the improvement is the preservation of this very excellent and important harbor of refuge. The effect of the improvement upon the commerce of the port is of minor consideration.

Proposed operations. — As all needed protective work has been completed and funds in hand are sufficient for maintenance, no estimate of additional funds required is submitted.

Commercial statistics. — The commerce of Provincetown is not large and in recent years has run from 27,000 to 30,000 tons per annum. The harbor is of importance mainly as an anchorage and a harbor of refuge, and as such has great value.

QUARTERS FOR PORT WARDEN OF GLOUCESTER AND ROCKPORT.

Acting under the provisions of chapter 747 of the Acts of 1914 and chapter 796 of the Acts of 1914 the Board, after full consideration, decided that suitable quarters could be provided in the rooms of the Gloucester Board of Trade, and under date of March 23, 1915, entered into a lease with the Gloucester Board of Trade for a part of the main room used and occupied by it in the city of Gloucester, covering an area of about 83 square feet, the Board of Trade to furnish heat, light and telephone service. This lease is for the term of one year from March 23, 1915, the rental being $150 per year. Subsequently desks and chairs were purchased and the premises put in order for use.

Although these quarters have been provided, and the Commonwealth is now paying rental, no use has thus far been made of them. For this reason it is recommended that the act under which this Board has been proceeding in providing quarters as aforesaid, namely, chapter 747 of the Acts of 1914, be repealed, to be in effect upon the termination of the present lease. This recommendation is embodied in the draft of a bill which has been submitted.

RED BROOK HARBOR, BOURNE.

In July, 1915, a communication was received from the selectmen of Bourne in relation to submerged rocks and piles near the town landing. An examination was made subsequently and a petition filed asking that these rocks and obstructions be removed. This subject was considered and it was concluded that it is inadvisable at this time to make the improvement desired.

ROCKPORT HARBOR.

In 1914 a channel and basin was dredged in this harbor and bowlders removed, at a cost of $5,175.88.

An examination has been made during the year with a view to dredging and the removal of obstructions, but without conclusive action thereon.

A map of this harbor is printed herewith.

Amount expended during the year, $957.24.

Total expenditure to Dec. 1, 1915, $12,865.38.

SALEM HARBOR.

Reference is made to House Document No. 1850 of 1915 for report relating to this harbor.

Operations by the Federal Government.

Operations and results prior to the fiscal year. — By dredging, a channel has been obtained 10 feet deep at mean low water from that depth in the harbor to about opposite the outer end of Derby Wharf, 300 feet in width at the entrance, gradually narrowing to 200 feet at Derby Wharf Light, thence 8 feet deep at mean low water, gradually narrowing to 100 feet in width near the inner end of Derby Wharf, and thence 6 feet deep at mean low water and 50 feet wide to the head of navigation at Lafayette Street Bridge. This channel had deteriorated from the outer end of Derby Wharf seaward so that it had a depth of about 8 feet at mean low water. The expenditures under the present project were $11,500 for original work.

Operations and results during the fiscal year. — Under contract, the channel from the outer end of Derby Wharf seaward was redredged to the project depth of 10 feet at mean low water. All work was for maintenance. The expenditures were $7,500.

Condition at the end of fiscal year. — The project was completed March 7, 1906. The channel was redredged in 1915 to the depth and width specified in the existing project. The expenditures were $11,500 for new work (which completed the project at a saving of $500) and $7,500 for maintenance, a total of $19,000.

Local cooperation. — No conditions have been imposed by law. The Commonwealth of Massachusetts, between 1909 and the present time, has improved South River from about opposite Derby Wharf Light to the head of navigation, so that there is now a dredged channel 10 feet deep at mean low water from the Federal Channel near Derby Wharf Light to above Central Wharf, and thence 8 feet deep to Salem Electric Lighting Co.'s Wharf. The State authorities, having expended for this work $13,222.13, are now arranging to deepen this channel to 12 feet and to extend it farther upstream.

Effect of improvement. — It is not believed that the improvement has resulted in any reduction in freight rates, but greatly improved facilities for navigation have been provided.

Proposed operations. — As no work is necessary, no estimate of additional funds required is submitted.

SALT POND RIVER, EASTHAM.

On April 13, 1915, a hearing was held on a petition of the selectmen of Eastham, and others, under chapter 481 of the Acts of 1909, for certain dredging in this river. No decision has thus far been made and the matter is still pending.

SALTERS POINT, DARTMOUTH.

In 1914 a breakwater about 400 feet long was built of quarry rubblestone in Buzzards Bay off Salters Point in the town of Dartmouth. About 280 feet of this breakwater is between two large rocks known as "Hunt's Rocks." The top of the breakwater is 5 feet wide at elevation 7 feet above mean low water. The cost of the work was $9,613.80.

The contract price was so favorable that it was decided to extend this breakwater, within the lines of the original plan, 200 feet westerly from Hunt's Rocks and a contract for this extension was entered into on Aug. 11, 1914, with E. S. Belden & Sons, the contract price being $1.47 per ton for furnishing stone and depositing it in place in the breakwater.

Work was completed Dec. 12, 1914, and consisted of an inshore extension of the breakwater built under previous contract, making a total length of breakwater under both contracts of 575 feet. The cost was $5,049.57.

On April 27, 1915, hearing was held on a petition of Alvin F. Waite, and others, under chapter 481 of the Acts of 1909, for an extension of this breakwater. A report with estimate of cost of the suggested extension was presented and considered by the Board. No further action has been taken on this petition.

Amount expended during the year, $5,424.56.

Total expenditure to Dec. 1, 1915, $14,960.72.

Sandwich Harbor.

A survey of this harbor and the adjoining territory was made in 1912, with a view to making a channel through the beach where the entrance to the harbor formerly existed. A report with estimates of cost was prepared by the Chief Engineer in January, 1913, and extracts therefrom may be found in the report of the Board for 1913, pages 98 and 99.

Two contracts were entered into in October, 1913, for excavating a channel, for certain protective work, and for constructing a stone and concrete jetty. The work accomplished comprised the dredging of a channel through the beach and in the harbor to a depth of 3 feet at mean low water, 50 feet wide on the bottom and about 100 feet long; also the building of a concrete wall 308 feet long, the facing of the same with heavy riprap, and riprapping the easterly bank of the channel through the old beach.

Under two contracts made in 1914 the channel previously excavated was widened to 75 feet and deepened to 4 feet at mean low water throughout the entire length of channel through the beach and in the harbor. The construction of a stone and concrete jetty on the westerly side of the new entrance channel, as well as other work included in one of these contracts, was not fully completed at the date of the last report of the Board.

This work was completed on Feb. 1, 1915, and consisted of the construction of a concrete wall 325 feet long on the center line of the westerly jetty. About 75 feet of the inner end of this jetty was partially destroyed during the storms of the past winter, 1914–15.

In August, 1915, the question of further work at this harbor was considered, and on Sept. 7, 1915, a contract was entered into with the Rockport Granite Company to repair the westerly jetty and to make an addition to the end of the easterly jetty. It was estimated that about 2,000 tons of stone would be required to complete the work. The contract price for furnishing stone and depositing it in place was $2.90 for each ton of 2,000 pounds. Work was completed Nov. 9, 1915, and consisted of the placing of about 250 tons of stone around the end of the easterly jetty and 1,711 tons of stone in the westerly jetty, extending the inshore end 132 feet, facing both sides of the concrete core wall and extending the outer end about 50 feet. The cost was $5,686.90.

By chapter 278 of the Special Acts of 1915 the town of Sandwich, for the purpose of improving its harbor and for constructing a public dock and landing and approaches thereto, was authorized to acquire by gift or purchase such land as may be necessary or desirable. Other provisions of the act are that the town may borrow, within the statutory limit of indebtedness, a sum not exceeding $10,000, and may issue notes or bonds of the town therefor; that the town is authorized to pay over to the Harbor and Land Commissioners any or all of the sums so borrowed, to be expended by the commissioners for the purposes specified in the act.

During the year several projects were prepared, estimates made of the probable cost, and conferences held with the selectmen of the town and other parties. In June, 1915, the Board deferred further action in this matter pending the results of a town meeting to be called in order that any doubt as to the legality of the action on the part of the town at a previous meeting in appropriating money for this harbor might be removed.

Amount expended during the year, $11,790.69.

Total expenditure to Dec. 1, 1915, $51,100.94.

SANDY BAY.

Operations by the Federal Government.

Operations and results prior to the fiscal year. — In general terms the substructure had been completed to about mean low water from Averys Ledge to the angle at Abners Ledge, known as the southern arm, and for about 2,500 feet from that point toward Andrews Point, known as the western arm. A total length of 625 feet of superstructure had been completed, of which 201 feet was on the western arm and 424 feet on the southern arm. The expenditures were $1,811,094.61 for original work and $1,484.47 for maintenance, a total of $1,812,579.08.

Operations and results during the fiscal year. — Under contract the new type of superstructure was extended on the southern arm 200 feet. The expenditures thereon were $65,769.73 for new work. In repair of various portions of the apron 627 tons of stone were deposited under contract and 1,852 tons under written proposal and acceptance. The expenditures for this maintenance work were $5,294.64, of which $1,366.86 was for the work under contract and $3,927.78 for work under written proposal and acceptance. The total expenditures during the year were $71,064.37, of which $65,769.73 was for new work and $5,294.64 for maintenance.

Condition at the end of fiscal year. — The project has been 26 per cent completed. A total length of 825 feet of superstructure is now completed. No material facilities or advantages to navigation have yet been derived. The expenditures were $1,876,864.34 for new work and $6,779.11 for maintenance, a total of $1,883,643.45.

Local cooperation. — None.

Effect of improvement. — The anchorage behind so much of the breakwater as has been built affords some protection to vessels, but it is very little used. The substructure on which superstructure has not been built serves to some extent to break the heavy roll of the sea.

Proposed operations. — No estimate of funds is submitted, as it is considered desirable to give further test to the ability of the present type of superstructure to withstand the unusually severe storm seas of this exposed locality before asking additional funds.

Commercial statistics. — As the breakwater is designed for a harbor of refuge only, no definite statements can be given as to the commerce affected. Various estimates have been made as to the number of vessels passing in the vicinity, some placing the number of all kinds as high as 70,000 annually. The commerce benefited at present is negligible.

Under date of July 23, 1915, the Chief of Engineers, U. S. A., reported to the Secretary of War on the subject of the examination of this harbor of refuge as follows: —

1. Under authority of section 14 of the River and Harbor Act, approved March 4, 1915, there are submitted herewith for transmission to Congress report dated June 21, 1915, with maps, by Col. W. E. Craighill, Corps of Engineers, and report dated June 30, 1915, by the Board of Engineers for Rivers and Harbors, relative to the project for improvement of the harbor of refuge at Sandy Bay, Cape Ann, Mass.

2. The project for the construction of this harbor of refuge was adopted by Congress in 1884 without favorable recommendation by this department. It provides for a breakwater extending from Averys Ledge a little west of north 3,600 feet to Abners Ledge, thence 5,400 feet northwesterly

in the direction of Andrews Point, protecting an area of about 1,377 acres. The original estimate of cost was $4,000,000, but this was subsequently increased to approximately $7,000,000. The total expenditures to date amount to about $2,000,000, leaving about $5,000,000, to be appropriated if the project is to be carried to completion. The district officer is of opinion that the benefits to be derived from completing this harbor of refuge are not sufficient to warrant the cost involved, and he therefore recommends the abandonment of the project. The division engineer and the Board of Engineers for Rivers and Harbors concur in this recommendation.

3. After due consideration of the above-mentioned reports I concur in the views of the district engineer officer, the division engineer, and the Board of Engineers for Rivers and Harbors, and therefore recommend that legislation be enacted authorizing the abandonment of the project for the construction of the harbor of refuge at Sandy Bay, Cape Ann, Mass.

DAN C. KINGMAN,
Chief of Engineers, United States Army.

SCITUATE HARBOR.

Under contract made in 1912 the channel from the wharves to the anchorage basin, a distance of 2,100 feet, was dredged by the Commonwealth to a depth of 6 feet at mean low water, the dredged channel being at least 60 feet wide throughout its course. In 1913 a contract was entered into for dredging to a depth of 8 feet at mean low water a channel 100 feet wide on the bottom extending from the harbor entrance to the wharves, a distance of 4,450 feet. Upon the completion of this work 1,000-ton barges could enter the harbor with full cargo.

By chapter 132 of the Resolves of 1914 the Board was authorized and directed to continue improvements at Scituate Harbor by dredging a wider entrance to the anchorage basin, and by extending the area of the anchorage basin by dredging to a depth of not less than 8 feet at mean low water, and to expend therefor a sum not exceeding $15,000.

On Aug. 4, 1914, a contract was entered into with the Bay State Dredging Company, Ltd., for dredging a channel and basin in this harbor and a channel to the yacht club pier, the channel at the entrance to the harbor to be 12 feet deep at mean low water, 150 feet wide on the bottom and about 900 feet long; the channel to the yacht club pier to be 5 feet deep at mean low water; the basin to be about 800 by 360 feet, and

8 feet deep at mean low water. The contract prices were: for dredging channels and basin, and disposing of the dredged material, 27½ cents per cubic yard measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $10 per cubic yard. Work under this contract was partially completed Dec. 14, 1914, and consisted of dredging the anchorage basin on the southerly side of the channel and a channel to the Scituate Yacht Club pier. The dredging of a channel at the entrance to the harbor was not completed at this date, owing to weather conditions, and it was concluded to carry it out under a separate contract at the price named in the contract of Aug. 4, 1914, aforesaid. The cost of work done under the contract of Aug. 4, 1914, was $23,092.23.

On May 18, 1915, a contract was entered into with the Bay State Dredging Company, Ltd., to dredge a channel at the entrance to the harbor 12 feet deep at mean low water, 150 feet wide on the bottom and about 900 feet long. The amount of material to be removed, including the required slopes, was estimated to be about 9,000 cubic yards, scow measurement. The contract prices were: for dredging channel and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 27½ cents for each cubic yard of material excavated, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $10 per cubic yard.

Work was completed Sept. 14, 1915. This channel joins the 8-foot channel dredged by the Commonwealth in 1913, and its purpose is to provide a safe approach to this channel in easterly storms. Under previous conditions the seas broke across the entrance to the channel, making it very dangerous for small craft to enter the harbor. The cost of the work was $3,932.77.

By chapter 508 of the Acts of 1914 the town of Scituate was authorized to purchase or take and to hold and maintain for the purpose of a wharf and public landing land bordering on Scituate Harbor and lying northerly of the northerly line of Burke's Wharf, so called, extending from Front Street to the channel. It was further provided that this act should be submitted to the voters of the town within three years after its passage, and that it should become operative upon its acceptance by a majority of the voters present and voting thereon. This act was accepted by the town of Scituate at a special town meeting held Oct. 17, 1914.

A petition of the town for approval of plans for a public wharf and landing under authority of the act of 1914 aforesaid was presented on June 15, 1915, and after public hearing thereon plans were approved and license granted on June 25, 1915.

On March 3, 1915, hearing was held on a petition of the selectmen of Scituate for certain dredging near the proposed town landing. An estimate of cost was made, plans and specifications prepared, and on May 5, 1915, a contract was entered into with the Bay State Dredging Company, Ltd., for dredging a basin and an extension of the channel near the town landing, the channel to be dredged to a depth of 8 feet at mean low water and the basin dredged to a depth of 6 feet at mean low water. The amount of material to be removed, including the required slopes, was estimated to be about 30,000 cubic yards. The contract prices were: for dredging the basin and channel and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 26.9 cents per cubic yard, scow measurement; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $10 for each cubic yard; for dredging the basin and channel and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, within the pier or its approaches that are to be built by the town of Scituate, 46 cents per cubic yard of material excavated measured in place in the pier or its approaches.

Work was completed Sept. 15, 1915. The amount of dredging as originally estimated was actually increased about 8,000 cubic yards on account of reduction made in the length of the pier, upon which the estimate was based. The cost of the work was $10,180.72.

A map of this harbor is printed herewith.

Amount expended during the year, $22,499.76.

Total expenditure to Dec. 1, 1915, $65,136.95.

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SCITUATE SEA WALLS.

On March 3, 1915, hearing was held on a petition of the selectmen of the town of Scituate, under chapter 481 of the Acts of 1909, for the extension southerly of the concrete sea wall on the beach between First and Second Cliffs in Scituate. Subsequently an examination of the locality was made showing that a considerable quantity of sand and gravel had been washed from the beach across the adjoining low land into the head waters of the harbor. The highway from the First Cliff to the Second Cliff was covered with sand and gravel. The selectmen stated that this effect was due to a recent storm accompanied by a very high tide, and that it was feared that if the beach was not protected from further erosion an opening might be made from the bay into the harbor.

On April 15, 1915, a contract was entered into with the firm of Susi & Williams for constructing an extension southerly of the concrete sea wall on the beach between the First and Second Cliffs; also the placing of riprap on the crest of the beach for a distance of about 175 feet southerly from the end of the proposed wall. The amount of concrete required to complete the work was estimated to be 400 cubic yards. The contract prices were: for furnishing materials and building the concrete sea wall, including the cost of excavation and other work, $5.24 per cubic yard of concrete measured in place in the completed work; for furnishing stone riprap and placing it on the crest and surface of the beach and grading, 85 cents per linear foot of crest of beach covered with riprap.

Work was completed June 10, 1915, and consisted of the construction of 544.87 linear feet of concrete sea wall and 199 linear feet of riprap protection to the crest of the beach between the southerly end of the wall and the high-water line of the Second Cliff. The cost was $2,261.99.

In 1907 and 1908 the Commonwealth built stone riprap protection for the bluff at the southerly end of the Third Cliff. On Sept. 8, 1915, a petition of Howard R. Guild, under chapter 481 of the Acts of 1909, for repair work at the southerly end of this cliff, was presented. Hearing was held on Sept. 15, 1915. An examination of the locality and an estimate of the probable cost having been prepared, and contributions amounting to $235 having been made toward the cost of the work, on Nov. 2, 1915, a contract was entered into with Dennis F. Crowley for the repairing of riprap on the southerly shore of this cliff. The contract price for furnishing stone and depositing it in place was $2.45 for each ton of 2,000 pounds. Work was in progress on Dec. 1, 1915.

Amount expended during the year, $2,827.81.

Total expenditure to Dec. 1, 1915, $42,684.02.

SESUIT HARBOR, DENNIS.

By chapter 355 of the Special Acts of 1915 the Board was authorized and directed to improve the entrance to Sesuit Harbor in the town of Dennis by the construction of a jetty or jetties and otherwise. For this purpose an expenditure of not exceeding $5,000 was authorized.

On July 20, 1915, the Board conferred with representatives of the board of selectmen. It appeared that the town desires the construction of a breakwater running about northeasterly and southwesterly for the purpose of preventing sand washing into the harbor. This breakwater was desired but no dredging was asked for. The Chief Engineer of the Board was instructed to make an examination and report as to what in his opinion was advisable, and his report under date of Oct. 13, 1915, was as follows: —

> I have prepared estimates of the cost of constructing a jetty at the entrance of Sesuit Harbor in the town of Dennis, as provided for under the provisions of chapter 355 of the Special Acts of 1915; but as the construction of a jetty or jetties does not meet the requirements of a workable plan for the improvement of the harbor I have enlarged the scope of the estimates to more fully meet the situation.
>
> Sesuit Harbor is at the mouth of a small tidal estuary emptying into Cape Cod Bay at East Dennis. A survey and map of the harbor was made under the direction of the Board in 1907, and as no material change appears to have taken place since that time I have used the map as the basis of the present estimate.
>
> About 1851 a timber jetty was built on the easterly side of the entrance to the creek, and remains of an ancient wharf still exist on the northerly shore of the creek as evidence of the business which it is claimed was carried on in this locality.

In 1909 and 1910 about 1,000 feet of the old jetty was rebuilt with stone by the Commonwealth to prevent the sand from being driven from the beach east of the entrance into the harbor by northeast winds. It was also thought that this structure would produce a scour in the channel that would in time restore its original depth. The results, however, have not justified this theory.

In the early days there was some ship building carried on in the creek, and small fishing craft frequented the harbor as there was a cold-storage plant on an easterly arm of the creek, but a few years ago this was destroyed by fire. It has been stated that this plant would be rebuilt if the harbor is improved so that it can be used by fishing craft of moderate draft.

The plan shows that the mean low water line is outside the outer end of the jetty, and that the whole of the outer harbor and most of the creek is dry at low tide. In fact, the bottom of the greater part of the channel is about 5 feet above mean low water. The upper portion of the creek is somewhat deeper, but the tidal volume of the creek is small and entirely inadequate to maintain a channel by its scouring action.

The jetty built by the Commonwealth has not appreciably increased the depth of the channel, and this should not be a matter of surprise as the general movement of the sand on this shore is to the east, which the jetty has intercepted on the channel side. No doubt the jetty has also prevented the westerly movement of sand in northeasterly storms, but the easterly movement is the more persistent.

The act directs that the entrance to the harbor shall be improved "by the construction of a jetty or jetties." The popular conception of the use of jetties is to confine the flow of the current so as to increase its velocity, and thus scour the bottom to a greater depth. The difficulty with this theory in its application to tidal waters is that the flow cannot be maintained in one direction, and the slackening of the current due either to the tidal change or to an increase in the cross-section of the channel causes a deposit of the suspended matter which creates new shoals.

In the situation under consideration there is no basin connected with the creek of sufficient tidal volume to produce a current of scouring velocity unless the channel is made too narrow for commercial use. There is also no deep water at either end of the channel to receive the material that is to be transported by the current. Therefore it is impracticable in my opinion to create a commercial channel in this harbor by the scouring action of the tidal currents.

A jetty is required on the westerly side of the channel to stop the easterly movement of the sand; but the depth must be secured by dredging, and the jetty should be located so as to avoid creating currents of scouring velocity.

It is quite apparent that the amount authorized by the act is entirely too small to produce, by itself, any improvement in the harbor, but it will pay for a portion of the cost of a comprehensive plan, which, when completed, will result in a permanent improvement.

I have considered two projects, one for a jetty starting near the mouth of the creek and extending to the 6-foot contour with a channel between the two jetties dredged to a depth of 6 feet at mean low water and a width on the bottom of 50 feet; the other for a jetty starting from the westerly shore about 700 feet from the mouth of the creek and following the location of a rocky shoal to a point near the outer end of the present jetty where it turns to the north and extends to the 6-foot contour, a channel to be dredged from the 6-foot contour to the creek of the same dimensions as in the first project. A small basin is also provided for in both projects, and the jetties should be about 200 feet apart on their center lines. The outer portion of both jetties should be at least 5 feet wide on top with sides sloped 1 on 1½, but the inshore sections may be 3 feet wide on top with sides sloped 1 on 1½.

Project 2 will require a shorter jetty than Project 1, and therefore a better start can be made with the funds at your disposal under the second plan; but the large shoal water basin formed by the diagonal jetty in the latter plan will tend to make it more difficult to maintain the channel than under the first plan.

The estimated cost of the two projects are as follows: —

PROJECT No. 1.

Channel 2,100 feet long, 50 feet wide on bottom, 6 feet deep at mean low water.
Basin 270 feet by 125 feet on bottom, 6 feet deep at mean low water.
Jetty 1,730 feet long, top at grade 12.
 900 feet 3 feet wide on top.
 830 feet 5 feet wide on top.

Estimate of Cost.

107,204 cubic yards dredging (63,844 in channel, 43,360 in basin) at $0.25,	$26,801 00
20,747 tons stone in jetty at $2.75,	57,054 00
Engineering and supervision,	4,000 00
Total,	$87,855 00

PROJECT No. 2.

Channel and basin same as in Project No. 1.
Jetty 1,320 feet long, top at grade 12.
 500 feet 3 feet wide on top.
 820 feet 5 feet wide on top.

Estimate of Cost.

107,204 cubic yards dredging channel and basin at $0.25,	$26,801 00
18,746 tons stone in jetty at $2.75,	51,551 50
Engineering and supervision,	4,000 00
Total,	$82,352 50

From 400 to 500 feet of the inshore end of the jetty in each project can be built for $5,000, but as I have already stated, it will not create any improvement in the present condition of the harbor unless it is followed up by a sufficient expenditure to complete some definite project such as I have used as the basis of my estimates.

I have not made any provision in either estimate for the possible extension of the present jetty, although it may be necessary, if easterly storms drive the sand into the outer portion of the channel.

The cost of extending this jetty to the 6-foot contour, a distance of about 600 feet, will be about $37,000.

It is impossible for any one to say that this extension will or will not be required; but as it is desirable to know the outside possible cost of such an undertaking, I think the cost of the extension should be added to both estimates.

Either project will produce only a small harbor for light draft boats which is all, in my judgment, that this locality will ever require, as it is only about 7 miles from Barnstable Harbor to the west and about 12 miles from Wellfleet Harbor to the east.

Your attention is also called to the omission from the estimates of the cost of extensions of the channel to provide for commercial developments on the shores of the creek above the basin. I am assuming that this will be provided for by the parties interested.

On Oct. 26, 1915, the Board considered this matter and concluded not to make expenditure of the appropriation provided by chapter 355 of the Special Acts of 1915, in view of this report and the estimates for improvements outlined therein. Attention is respectfully called to the fact that this appropriation was made without obtaining in advance a comparative estimate of cost of the best method of improving this harbor. This procedure does not conform to that followed by the Board in considering applications under chapter 481 of the Acts of 1909 for an allotment for river and harbor improvement, which provides that "no work authorized by this act shall be begun until after public hearing has been held and a survey and estimate of the cost has been made." It is apparent that the expenditure of the appropriation made by the Legislature for the improvement of this harbor, namely, $5,000, is at wide variance with the estimated cost of a proper and well-considered project of improvement.

Total expenditure to Dec. 1, 1915, $20,471.30.

SOUTH RIVER, SALEM.

In June, 1915, conference was held with the chairman of the committee on maritime affairs of the Salem Chamber of Commerce and Civics, and others, in relation to a petition of the Salem Electric Lighting Company, under chapter 481 of the Acts of 1909, for further improvement of this river by dredging. Plans and specifications were prepared, and on July 7, 1915, proposals for dredging a channel were received, the channel to be 90 feet wide on the bottom and 12 feet deep at mean low water from a point southwesterly of Derby Wharf Light to a point opposite the southerly end of Central Wharf. and 50 feet wide on the bottom and 12 feet deep at mean low water from Central Wharf to 750 feet westerly of Union Street bridge.

A contribution of $1,500 having been received from the Salem Electric Lighting Company, it was concluded to enter into a contract to carry out this work upon the receipt of certain releases from any claims for damages which the owners of land and flats at and near the area to be dredged might have as a result of the proposed dredging. These releases, however, were not all obtained, and the Board was thus obliged to abandon the project.

Amount expended during the year, $64.72.

Total expenditure to Dec. 1, 1915, $13,461.76.

STAGE HARBOR, CHATHAM.

On June 1, 1915, the Board gave a public hearing on petitions of Heman A. Harding, and others, under chapter 481 of the Acts of 1909, for survey, plans and estimates of cost of improvement of Stage Harbor, Chatham Roads and vicinity. On July 28, 1915, the Chief Engineer was directed to make this survey. A plan embodying the results of this work is printed herewith. No estimates of cost of improvement have been made.

A map of this harbor is printed herewith.

Amount expended during the year, $1,508.28.

Total expenditure to Dec. 1, 1915, $10,740.21.

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TAUNTON RIVER.

The recommendation that Taunton River from Fall River to Weir Village in Taunton be improved by providing a channel not less than 100 feet in width and not less than 18 feet deep at mean low water, with rectification of bends and a wider basin at the upper extremity of the channel, and that the necessary work be carried out in co-operation between the Commonwealth of Massachusetts, the Federal government and municipalities, was fully set forth in the special report of this Board printed as House Document No. 2138 of 1913. This was followed by the passage of chapter 716 of the Acts of 1914, allowing an expenditure of $100,000 for the improvement for navigation of that part of the river named above, and for payment for land purchased or taken, for land damages and other rights, and for the privilege of depositing material on land and flats of and adjoining the river: "*provided*, that no part of this fund shall be available or expended until the congress of the United States shall approve a project, and make appropriation therefor, to improve that part of said river extending from Fall River to Weir Village in Taunton by the construction of a continuous channel therein."

On Oct. 15, 1915, the Board attended a public hearing held by Col. John Millis, Corps of Engineers, U. S. A., at Taunton in relation to a report in preparation by him as to further improvement of this river from Fall River to Weir Village in Taunton under authority of an act of Congress. It was pointed out by Colonel Millis that favorable action by the State with respect to a waterway between Taunton and Brockton, extended eventually either to North River or to Boston Harbor, following surveys, examinations and estimates of cost made by this Board, would have an important bearing upon the question of the advisability of further improvement by the Federal government of Taunton River from Fall River to Weir Village.

Total expenditure to Dec. 1, 1915, $1,960.51.

TAUNTON AND BROCKTON WATERWAY.

By chapter 103 of the Resolves of 1915 the Board was authorized to make such examinations and surveys as it might deem necessary of that part of the Taunton River from Weir Village in the city of Taunton to the dam across said river in that part of the town of Bridgewater known as Pratttown, and of the territory lying between said dam and the city of Brockton, for the purpose of determining the advisability, practicability and approximate cost of providing a continuous waterway between Taunton River and the city of Brockton, utilizing wholly or in part Taunton River as far as said dam and constructing in connection with said river a canal between said dam and the city of Taunton. The Board was authorized to expend for the purpose of the resolve a sum not exceeding $2,500, and directed to report the result of its examination and survey to the Legislature on or before the second Wednesday in January, 1916.

Up to Dec. 1, 1915, a portion of the work required to carry out the provisions of the resolve of 1915 aforesaid had been done, and will be set forth in a preliminary report.

In order to carry out more fully the purpose of this resolve it is recommended that further time be granted, and that the Board be allowed to expend such amounts as it may deem necessary and advisable therefor, in addition to the amount authorized to be expended as aforesaid, from the unexpended balance of $4,095.72 remaining from an appropriation of $10,000 provided under authority of chapter 112 of the Resolves of 1914. This recommendation has been embodied in a draft of a resolve submitted.

Amount expended during the year, $3,059.08, which is the total expenditure to Dec. 1, 1915.

VINEYARD HAVEN HARBOR.

The improvement of this harbor by the Commonwealth was begun in 1905. Since that time a stone breakwater 1,213 feet long has been constructed on the shoal ground on the westerly side of the harbor northerly of the steamboat wharf. The main channel was dredged in 1913 to a depth of 15 feet at mean low water, between the red buoy off the end of the breakwater and the steamboat wharf.

Chapter 126 of the Resolves of 1915 provided that if the town of Tisbury should appropriate $1,000 to be paid into the treasury of the Commonwealth there should be expended by the Harbor and Land Commissioners $10,000 for the purpose of extending the breakwater in said town and increasing its height.

On July 7, 1915, at a special town meeting the town voted to appropriate $1,000, and on Aug. 4, 1915, a contract was entered into with the Bay State Dredging Company, Ltd., to enlarge this breakwater by raising and extending the same on its northerly side from the angle near the shore end southeasterly about 1,215 feet to a point opposite the beacon. The contract prices were: for furnishing the stone and depositing it in place in the breakwater $1.34 for each ton of 2,000 pounds; for furnishing and setting in place each iron clamp in stone caps near beacon at the outer end of the breakwater $5 for each clamp.

Work was completed Oct. 20, 1915, and consisted of raising the breakwater from grade 4 feet to grade 9 feet from the beacon at the outer end of the angle near the inshore end, a distance of 988 feet. The finished top of the breakwater is 5 feet wide, and is capped with stone of the same width and not less than 18 inches thick and 4 feet long. The cost was $9,452.88.

Amount expended during the year, $8,471.62.

Total expenditure to Dec. 1, 1915, $44,038.37.

VINEYARD HAVEN SEA WALL.

On Feb. 16, 1915, hearing was held on a petition of the selectmen of Tisbury for the construction of a concrete sea wall in front of the road leading from Vineyard Haven to Oak Bluffs. This wall was desired to protect the road from overflow by the sea and consequent washing away of the roadbed, such as occurred in northeast storms of the winter. After an examination and estimate of cost, plans and specifications were prepared and proposals received on May 12, 1915. Subsequently the town of Tisbury made a contribution of $630.50 toward the cost of the proposed work.

On May 12, 1915, a contract was entered into with Herbert N. Hinckley for the construction of this wall, the same to begin at the southerly end of a concrete wall built by the town and to extend in a southwesterly direction about 1,475 feet. The contract price for furnishing materials and building this wall, including the cost of reinforcing steel, tile drains, removal of wall, excavation, back filling, disposal of surplus material, furnishing, erecting and removing forms, and all incidental work, was $6.75 for each cubic yard of concrete measured in place in the completed work.

Work under this contract was completed Nov. 9, 1915, and consisted of the construction of 1,483 linear feet of reinforced concrete wall on the sea side of a rubblestone wall previously built by the town to retain the highway, with the top of the concrete wall at grade 9.23 or about 3½ feet above the surface of the road. The cost was $7,836.75.

On Nov. 9, 1915, there was presented to the Board a request of the selectmen of Tisbury for the extension of the concrete sea wall then under construction. A contribution of $750 was made by the town toward the cost of the desired work, and on Nov. 11, 1915, a contract was entered into with Herbert N. Hinckley for the construction of this extension, the proposed wall to begin at the southerly end of the concrete wall built by the State and extend in a southwesterly direction about 110 feet. The contract price for furnishing materials and building the reinforced concrete sea wall, including the cost of reinforcing steel, tile drains, excavation, back filling, disposal of surplus material, furnishing, erecting and removing forms, and all incidental work, was $9 for each cubic yard of concrete measured in place in the completed work. This work is now in progress.

Amount expended during the year, $6,942.19, which is the total expenditure to Dec. 1, 1915.

WAQUOIT BAY.

Waquoit Bay is located in the towns of Falmouth and Mashpee. Under authority of chapter 42 of the Resolves of 1900 a survey of this bay was made by the Board, and three projects for its improvement, together with estimates of cost, were prepared as follows: —

(1) For improving the entrance by building stone jetties and dredging at a total cost of $88,300.

(2) For cutting a channel through the beach to the west of the existing entrance, and the protection of the new entrance by jetties at an estimated total cost of $73,000.

(3) This project differs from the others only in cutting a new entrance to the east of the existing entrance at a total cost, with the jetties, of $61,380.

It was reported that while the carrying out of any one of these projects would undoubtedly increase the use of the bay the public advantage could hardly be deemed commensurate with the cost.

On March 3, 1915, the Board held a public hearing on petitions of D. E. Butler, and others, and of the selectmen of Falmouth, and others, for cutting a channel through the beach from the sound into Waquoit Bay. Subsequently a survey, examination and estimates of cost were made. No further action has been taken on these petitions, inasmuch as the funds at the disposal of the Board are not sufficient to carry out the desired work.

Amount expended during the year, $370.78.

Total expenditure to Dec. 1, 1915, $1,072.39.

WAREHAM RIVER.

Reference is made to House Document No. 1850 of 1915 for report relating to this river. A map of this river is printed with the report of the Board for 1914.

WARRENS COVE, PLYMOUTH.

On April 27, 1915, a hearing was held on a petition of the selectmen of the town of Plymouth for the construction by the Commonwealth of a sea wall along the shore of Warrens Cove in the town of Plymouth in front of property owned by the town. It was found that in northeast storms the sea washes over the beach in this locality carrying sand and gravel into Eel River, causing it to flood lands above this point. An approximate estimate of the cost of a concrete wall was prepared, and a contribution of $1,150 having been received from the town of Plymouth, a contract was entered into on June 9, 1915, with the Concrete Construction Company for building a concrete sea wall with spur jetties on the shore of said cove, beginning near the easterly end of an old riprap wall and extending in an easterly direction about 375 feet along the shore on property of said town. The contract prices were: for furnishing materials and building the wall and spur jetties, including the cost of excavation, back filling, etc., the sum of $5.70 per cubic yard of concrete measured in place in the completed work. Work was completed Sept. 24, 1915, at a total cost of $2,480.11.

In September, 1915, petitions were received from Edward L. Burgess, and others, for an extension of the wall built by the Commonwealth as above described. An estimate of cost was prepared, and contributions to the amount of $2,094.77 having been received, a contract was entered into on Nov. 5, 1915, with Dennis F. Crowley to extend the wall previously built by the Commonwealth, in an easterly direction about 490 feet, and to build spur jetties in connection with said wall. The contract price for furnishing materials and building the wall and spur jetties, including the cost of excavation, etc., was $5.70 per cubic yard of concrete measured in place in the completed work. On Dec. 1, 1915, work was in progress.

Amount expended during the year, $2,038.59, which is the total expenditure to Dec. 1, 1915.

Wellfleet Harbor.

Reference is made to House Document No. 1850 of 1915 for report relating to this harbor. A map of the harbor is printed with the annual report of the Board for 1914.

By chapter 121 of the Resolves of 1915 the Board was authorized to dredge and improve this harbor at an expense not exceeding $18,000, of which amount $16,500 is to be paid by the Commonwealth and $1,500 appropriated by the town of Wellfleet.

Plans and specifications were prepared and the work advertised. The appropriation having been made by the town, a contract was entered into under date of Aug. 4, 1915, with John H. Gerrish to dredge a channel and basin, the channel to extend from the 6-foot contour in the harbor northerly about 2,400 feet to the proposed basin near the town landing, and to be 50 feet wide on the bottom and 6 feet deep at mean low water, the basin to be about 250 feet wide and 400 feet long on the bottom and 6 feet deep at mean low water. It was estimated that the amount of material to be removed, including the required slopes, was about 57,000 cubic yards, scow measurement. The contract prices were: for dredging the channel and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 14.3 cents for each cubic yard of material, measured in scows; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $6 for each cubic yard. Work had not been commenced up to Dec. 1, 1915.

Amount expended during the year, $284.16.

Total expenditure to Dec. 1, 1915, $564.38.

WILD HARBOR, FALMOUTH.

Wild Harbor, Falmouth, is a small bay or cove on the easterly shore of Buzzards Bay, opening to the southwest. The mouth of the cove is so wide that practically none of the area suitable for the anchorage of boats is protected during the summer from prevailing southwesterly winds.

On Feb. 27, 1914, a petition of G. E. F. Donkin, and others, under chapter 481 of the Acts of 1909, for the improvement of this harbor, was received. A hearing was held on March 3, 1914.

On Sept. 8, 1914, a contract was entered into with the J. S. Packard Dredging Company to dredge to a depth of 5 feet at mean low water a basin and a channel to the same from this harbor. The contract prices were: for dredging the channel and basin and disposing of the dredged material, 31.9 cents per cubic yard, scow measurement; for excavating bowlders in excess of 1 cubic yard and not greater than 5 cubic yards in volume, and disposing of the same, $9 per cubic yard; for dredging basin and channel and disposing of material on land

and flats, including the construction of suitable dikes and all incidental work, 32 cents per cubic yard, measured *in situ.*

Work was completed Jan. 4, 1915, and consisted of dredging a channel 50 feet wide on the bottom and not less than 5 feet deep at mean low water from the harbor through the beach to the basin, which was also excavated to a depth of not less than 5 feet at mean low water over an area about 325 by 200 feet. The cost was $12,800.

An examination made in August, 1915, revealed a rapid shoaling in the channel through the beach, and made evident the necessity for further improvement. On Aug. 18, 1915, a contract was entered into with John R. Burke for the construction of a stone jetty and the placing of riprap on the southerly bank of the channel through the beach, and dredging the channel at the entrance to the basin to a depth of 5 feet at mean low water and a width of 50 feet on the bottom. The contract prices were: for dredging shoal in channel and disposing of the dredged material, including bowlders 1 cubic yard or less in volume, 36 cents per cubic yard, measured in scows; for furnishing the stone and riprap and depositing it in place in the jetty and along the bank, $2.60 for each ton of 2,000 pounds.

Work was completed Oct. 25, 1915, and consisted of dredging the channel to its original width of 50 feet on the bottom and to a depth of 6 feet at mean low water, the construction of a stone jetty about 100 feet long, and riprapping the southerly side of the channel through the beach. The cost was $2,186.60.

Amount expended during the year, $14,744.55.

Total expenditure to Dec. 1, 1915, $15,013.86.

WINTHROP SEA WALL.

By chapter 139 of the Resolves of 1915 the Board was authorized to provide for the building of a sea wall in the town of Winthrop along the shore of Broad Sound on the easterly side of Point Shirley, and to expend for the purpose a sum not exceeding $18,000, of which amount $15,000 was to be paid by the Commonwealth and $3,000 appropriated by the town of Winthrop.

Plans and specifications were prepared and the work advertised. The appropriation was made by the town of Winthrop at a meeting held Sept. 22, 1915.

On Nov. 5, 1915, a contract was entered into with the William L. Miller Company for the construction of a concrete sea wall, timber bulkheads and timber jetties, the proposed wall to begin about 1,150 feet southerly from the existing wall and to extend in a southerly direction about 1,030 feet, with timber bulkheads on the inshore side of both ends of the wall and timber jetties extending from the easterly face of the wall. The contract prices were: for furnishing the materials and building the concrete sea wall, including excavation, back filling, furnishing, erecting and removing forms, and all incidental work, $6.09 for each cubic yard of concrete measured in place in the completed work; for furnishing materials and building seven jetties of yellow pine timber and oak piles, including coating piles and timber, excavating, back filling and all incidental work, $6.50 for each linear foot of pile and timber jetty in place; for furnishing materials and building two bulkheads of yellow pine timber and oak piles, including coating piles and timber, excavating, back filling and all incidental work, $6.33 for each linear foot of pile and timber bulkhead in place. Up to Dec. 1, 1915, work had not been commenced.

Amount expended during the year, $196.70, which is the total expenditure to Dec. 1, 1915.

WOODS HOLE CHANNEL.

Operations by the Federal Government.

Operations and results during the fiscal year. — No works of improvement were in progress during the fiscal year. Total expenditure was $10.21, all of which was for contingencies and charged as new work.

Condition at the end of fiscal year. — The general project is about 90 per cent completed. The main channel through the strait has a width of 300 feet and a navigable depth of about 13 feet at mean low water, and the branch or Broadway channel leading toward Vineyard Sound has the same width and a minimum depth of 11 feet. The total expenditure under the existing project was $230,000, all of which was for new work.

Local cooperation. — None.

Effect of improvement. — The deepening and widening of the main channel and its branch enables vessels of larger size to pass between Buz-

zards Bay and Vineyard Sound and to use Great Harbor at the entrance of the sound. So far as known, the improvement has had no effect on freight rates.

Proposed operations. — No operations contemplated at this time.

WORCESTER-NORWICH CANAL.

Two members of the Board attended a public hearing held on Oct. 27, 1915, in the city of Worcester by Maj. G. B. Pillsbury, Corps of Engineers, U. S. A., stationed at New London, Conn., in relation to the provision of the River and Harbor Act approved March 4, 1915, providing for a preliminary examination and survey of the Shetucket and Quinebaug rivers, Connecticut, and French River, Connecticut and Massachusetts, with a view to securing slack-water navigation between Norwich, Conn., and Worcester, Mass. Subsequently Major Pillsbury reported unfavorably on this improvement.

GREAT PONDS.

The jurisdiction of the Board over Great Ponds belonging to the Commonwealth, those ponds containing in their natural state 10 or more acres of land, was conferred by chapter 318 of the Acts of 1888. Further authority was given by chapter 379 of the Acts of 1904, allowing the Board, subject to the approval of the Governor and Council, to sell and convey or lease any of the islands owned by the State in the Great Ponds.

During the year examinations have been made, conferences and hearings held and other proceedings taken relative to Bartlett Pond, Plymouth; Bass Lake, Springfield; Bates Pond, Carver; Brown's Pond, Peabody; Chebacco Lake, Essex; Crystal Lake, Newton; East and West Monponsett Ponds, Halifax and Hanson; Ell Pond, Melrose; Forge Pond, Littleton; Gibbs Pond, Nantucket; Great Herring Pond, Plymouth and Bourne; Great Island Pond, Plymouth; Hampton Pond, Westfield and Southampton; Horse Pond, Westfield; Indian Pond, Kingston; Little Herring Pond, Plymouth; Lake Quinsigamond, Shrewsbury and Worcester; Lake Whalom, Leominster and Lunenburg; Lake Winthrop, Holliston; Long Pond, Bourne; Long Pond, Harwich; Maquan Pond, Hanson; Martins Pond, North Reading; Morse Pond, Wellesley; Nipmuck Pond, Mendon;

Nuttings Pond, Billerica; Pontoosuc Lake, Pittsfield; Sampsons Pond, Carver; Seymours Pond, Harwich; Snipatuit Pond, Rochester; Stillwater Pond, Chatham; Ward Pond, Ashburnham; Wenham Lake, Beverly; Wenham Pond, Carver; Yokum Pond, Becket.

In some of these ponds encroachments upon the waters had been made without license or other authority of law. In others structures had been built and the waters raised or lowered at will, injuriously affecting the property and rights of the shore owners, involving an investigation and consideration on the part of the Board of alleged claims of right under old charters and ancient deeds. Questions affecting the location and extent of the Commonwealth's ownership have also been involved.

Many of the Great Ponds are of importance as sources of supply for flowing cranberry bogs, and the shores and surrounding lands, as well as the islands therein, have increased largely in value during recent years and become desirable locations for camps and permanent residences.

In the exercise of its powers and duties with reference to the majority of cases concerning Great Ponds and the islands therein the Board is restricted in its activities owing to the fact that accurate and complete surveys, maps and plans of only a few of these ponds have been made by the Commonwealth. Neither is the Board always able to report as fully as is desirable to the Attorney-General, at his request, facts and information needed by that official for a determination of questions of ownership by the State or of public rights involved in certain petitions of private parties to the Land Court for registration of title.

The Board therefore again recommends that it be given the necessary authority to make surveys, examinations, maps and plans of the Great Ponds of the Commonwealth containing 10 or more acres of land, also of the islands in said ponds, and to ascertain, so far as is practicable, the location, extent and description of the lands, shores and islands in said ponds, and that an appropriation therefor be made. This recommendation is embodied in a draft of a bill submitted.

PROVINCE LANDS.

By chapter 470 of the Acts of 1893 the Board of Harbor and Land Commissioners was given the general care and supervision of so much of the Province Lands as lie northerly and westerly of the line described in the act, together with authority to fix bounds, to establish regulations for the care of the lands and to appoint a superintendent, the whole territory comprising about 3,290 acres.

In the same year, under an appropriation of $2,000 made by the act aforesaid, the work of reclamation on these lands was begun in order to "stop the shifting sands which move like drifting snow, and cover these barren sections with vegetable growth."

The methods of dealing with the problem of reclamation of the shifting dunes, worked out in the early years by careful experiment and under the advice of government experts, have been those followed since, with only the slight modifications due to changing conditions. The barren dunes are first planted with beach grass which prevents movement of the sand. When this growth is sufficiently sturdy it is reinforced by the transplanting of certain trees and shrubs, taken in part from a nursery established upon these lands. Scotch broom, bayberry, Scotch, Austrian and native pines have proven most valuable for this purpose.

During the year the work of reclamation has been carried on in accordance with the methods outlined, about 42 acres having been covered with brush, and 2,400 seedling pines, 8,500 Scotch broom and 12,400 black locust transplanted.

In 1913 and 1914, by authority of chapter 88 of the Resolves of 1913, the Massachusetts Highway Commission repaired and resurfaced a road built across these lands to Race Point Life Saving Station.

As a result of inspections made by the Board in 1914, in company with the State Forester on one occasion, and with the Commissioners on Fisheries and Game on another, reports were received from the State Forester containing his recommendations as to the forested area and suggestions as to the gypsy and brown-tail moth problems and co-operation in giving nursery stock for planting, and from the Commissioners on Fisheries and Game, containing suggestions and offering its co-operation in the stocking of this territory with fish and game. These reports are printed with the report of the Board for 1914, pages 79 to 82.

In August, 1915, there was received from the Commissioners on Fisheries and Game 50 mallard ducks which were liberated in the several ponds. This was followed with a consignment of 24 quail.

During the year the superintendent was instructed and directed to remove from the forested area, in order to destroy the gypsy and brown-tail moths, such trees as shall be designated by the State Forester or his authorized agent, and to plant within areas so designated local pines.

The sum of $152.53 has been paid into the State treasury during the year, being the amount received from licenses issued to various parties to cultivate and pick cranberries on the bogs and to mow meadow lands.

Reclamation work, involving the covering of the exposed sand dunes with trees and vegetation, has been carried on for a number of years with satisfactory results. It is recommended that further appropriations, and in larger amounts than hitherto, be made and thus enable the Board to continue the reclamation work and make more accessible for use by the public this large holding of the State. This recommendation has been embodied in the draft of a bill submitted.

Amount expended during the year, $2,392.76.

Total expenditure to Dec. 1, 1915, $65,568.60.

STATE BOUNDARIES.

Chapter 1 of the Revised Laws, section 4, requires that the Board of Harbor and Land Commissioners shall in the year 1905 and every fifth year thereafter examine and inspect all the monuments or other marks defining the location of the boundary lines of the Commonwealth, and if any of them have been injured, displaced, removed or lost said commissioners shall, in co-operation with persons duly authorized by the adjoining State, restore them or replace them with suitable stone monuments, and in the same manner set suitable stone monuments at points not properly marked where the State boundary is intersected by the boundary of any counties, cities or towns in the Commonwealth or by a highway or railroad. By chapter 68 of the Special Acts of 1915 an appropriation of $1,500 was made for expenses covering the examination and inspection and other work required by section 4 of chapter 1 of the Revised Laws, aforesaid.

On June 28, 1915, the members of the Board conferred at Providence, R. I., with commissioners appointed by the Governor of Rhode Island under the provisions of a resolve of the General Assembly of that State. It was ascertained at this conference that the Rhode Island commission had no authority to act as a representative of that State with the representatives of Massachusetts in perambulating the entire boundary line between the two States. It was concluded at this conference that the Rhode Island commission, appointed as above stated, request the Governor to designate a representative to act with a representative of this Board in the examination of the State boundary line between Massachusetts and Rhode Island as provided for in the Revised Laws of Massachusetts.

The boundary line between these two States was perambulated, in company with Everett A. Kingsley, commissioner for Rhode Island, in September, 1915. It was found that five bounds should be reset on this line, one bound furnished with marker, one bound repaired and one bound furnished with a finder. The necessary work was completed Sept. 28, 1915.

The line between Massachusetts and Connecticut was perambulated in August and September, 1915, in company with Henry R. Buck, who was appointed to represent the State of Connecticut. It was found that two new bounds should be set on this line and two bounds reset. The necessary work was subsequently carried out.

The line between Massachusetts and New York was perambulated during October, 1915, in company with G. W. Codwise, who was appointed to represent the State of New York. Bound No. 11 could not be found on account of heavy undergrowth; bound No. 35 was damaged but could be repaired; bound No. 79 requires more filling material around its base;

and bound No. 82 leans to the south and should be straightened. New York desires to set four new bounds at the following town corners which were omitted in 1898 because the lines had not been run out: —

No. 68A, corner of Canaan, Hancock and New Lebanon.
No. 81A, corner of Hancock, New Lebanon and Stephentown.
No. 93A, corner of Berlin, Hancock and Stephentown.
No. 106A, corner of Berlin, Petersburg and Williamstown.

That State also desires to cut out the line where it is now covered with a seventeen years' growth of scrub oak, birch and young maple, which makes it very difficult to perambulate the line and find the bounds. The heavy growth is in separate locations and covers altogether about 15 miles of the line.

The line between Massachusetts and Vermont was perambulated in November, 1915, in company with Robert R. Twitchell, who was appointed to represent the State of Vermont. The various monuments on this line were found in good condition, with the following exceptions: bound No. 18 and bound No. 46 require straightening and supporting. Five new monuments are required to completely mark the line, as follows: —

No. 6A, corner Bernardston-Guilford (Vt.)-Vernon (Vt.).
No. 16A, corner Colrain-Guilford (Vt.)-Halifax (Vt.).
No. 25A, corner Halifax (Vt.)-Heath-Whitingham (Vt.).
No. 35A, corner Monroe-Readsboro (Vt.)-Whitingham.
No. 48A, Larrabee Road, west side.

The line between Massachusetts and New Hampshire was perambulated in November, 1915, in company with William A. Grover, who was appointed to represent the State of New Hampshire. The monuments were inspected and found in good condition, with the exception of bounds Nos. 132, 135, 136, 137 and 153, which require straightening and supporting. Three new monuments are required to more completely mark the line, as follows: —

No. 79, west bank Nashua River on line with Varnum monument which was found to be 2 feet under water.

No. 91A, east bank Merrimac River.

No. 96A, east shore Long Pond.

It is estimated that the cost of setting new bounds, resetting and repairing existing bounds, and the cutting and removal of trees and undergrowth on, near and along various portions of the boundary lines between the State of Massachusetts and the States of New York, Vermont and New Hampshire will be about $3,000. It is recommended that an appropriation of $1,500 to pay one-half the cost of this work be made, provided, however, that no part of this sum shall be available or expended until evidence is presented to the Auditor of the Commonwealth that there has been appropriated or contributed and made available for use by the adjoining States of New York, Vermont and New Hampshire the sum of $1,500 for the purpose of paying one-half of the cost of the work aforesaid. This recommendation has been embodied in the draft of a resolve submitted.

The necessity for this additional appropriation is occasioned by the lack of funds available for work from the appropriation of $1,500 made by chapter 68 of the Special Acts of 1915.

A list of the various bounds and monuments inspected on the boundary lines between Massachusetts and the several States has been prepared, and will be filed in the office of the Secretary of the Commonwealth.

Massachusetts Atlas Sheets and Town Boundary Atlases.

Under authority of chapter 57, Resolves of 1890, chapter 42, Resolves of 1891, and chapter 360, Acts of 1900, 3,455 atlas sheets of the map of the Commonwealth and 4 town boundary atlases have been sold during the year, for which $346.40 was received. Under the provisions of chapter 26, Resolves of 1909, there has been expended from this amount $162 for the purchase from the United States Geological Survey of sheets required to keep in stock at all times copies of all the atlas sheets, leaving a balance of $184.40, which has been forwarded to the Treasurer and Receiver-General, as required by the resolve.

Sixty-four atlases have been delivered during the year under the authority of chapter 360, Acts of 1900, as amended by chapter 484 of the Acts of 1909.

Chapter 69 of the Resolves of 1915 was passed authorizing and directing the Board to make necessary changes in and additions to the atlas sheets comprising the topographical map of Massachusetts prepared by the United States Geological Survey, to publish an edition or editions of those atlas sheets with changes and additions, and to sell to the public the corrected sheets. An expenditure of not exceeding $10,000 was allowed.

Duplicate sheets of the topographical survey of the Commonwealth have been secured from the United States Geological Survey, Department of the Interior, Washington, D. C., and the corrections and additions are now being made on these sheets from information on file in this department and in other departments of the Commonwealth.

When the corrections are completed, arrangements will be made with the United States Geological Survey to either have the corrections and additions incorporated upon the original copper plates, or, if this is not found to be advisable, transfers can be obtained from the Federal government from which corrections can be made on the stones for lithographic purposes.

Areas of Counties, Cities and Towns.

There is printed in the Appendix of this report a table showing the areas of counties, cities and towns in Massachusetts, as of Nov. 30, 1915.

Appropriation for Survey and Improvement of Harbors.

By chapter 68 of the Special Acts of 1915 an appropriation of $1,500 was made for surveys of harbors and for improving and preserving the same, and for repairing damages occasioned by storms along the coast line or river banks of the Commonwealth.

Expenditures from this appropriation have been made to Dec. 1, 1915, in the localities and to the amounts following, viz.: —

Herring River, Harwich, repairs and riprap,	$635 91
Nobscusset Point, Dennis, dike and stone,	357 00
Scituate, Third Cliff, riprap,	507 09
Total,	$1,500 00

Wrecks and Obstructions.

During the year a scow which had remained in East Bay, Osterville, for a considerable period, and was an obstruction to boating in that locality, was removed from tidewater.

Amount expended during the year, $18.30.

Cape Cod Canal.

Under the provisions of chapter 448 of the Acts of 1899, incorporating the Boston, Cape Cod & New York Canal Company, the Board of Railroad Commissioners and the Board of Harbor and Land Commissioners were constituted a Joint Board for the purpose defined in said act.

The act of 1899 was amended by chapter 476 of the Acts of 1900. Additional legislation is contained in chapter 519 of the Acts of 1910. Statements covering previous proceedings before this Board and the Joint Board, and action taken on the several petitions presented, are contained in the reports of this Board for the years 1907, pages 98 to 104; 1909, pages 17 to 19; 1910, pages 34 to 38; 1911, pages 65 to 68; 1912, pages 74 to 77; 1913, pages 160 to 162; 1914, pages 87 to 91.

The Joint Board has authorized under its orders the issue by the canal company up to Nov. 30, 1915, of 52,320 shares of stock of the par value of $100 each and $5,240,000 in bonds. These orders were made in accordance with the requirements of chapter 448 of the Acts of 1899, as amended by chapter 476 of the Acts of 1900, and upon requisition of the Cape Cod Construction Company to the canal company for the amounts of stock and bonds of the canal company under and in accordance with the contract between the canal company and the construction company dated March 27, 1907, for the construction of the canal, accompanied by estimates prepared by the Chief Engineer of the canal company of the amount of work done and expenditures made which had previously been examined and verified by the Joint Board and its engineer. Other requisitions relating to additional issues of stock and bonds aggregating 7,580 shares of stock of the par value of $100 each, and $760,000 in bonds, have been presented to the Joint

Board, but the necessary orders have been withheld pending a determination of the question of a lock, tidal gates or other device for controlling the current of the canal, the question of a permanent ferry or a bridge at the crossing of the canal at Bournedale, and other matters.

Since the report of the Board for 1914 the Supreme Judicial Court has issued a decree in the case of the Inhabitants of the town of Bourne *v.* William S. McNary, *et al.*, concerning the establishment of a temporary ferry for crossing the canal at Bournedale, to the effect that the Joint Board has authority to ascertain by trial and experiment what form of ferry, bridge or tunnel would be adopted and how the traffic should be regulated, and that the establishment of a suitable passenger ferry was within its power. No conclusive action has yet been taken by the Joint Board with respect to a bridge or permanent ferry for passengers and vehicles at this crossing.

On Jan. 5, 1915, the Harbor and Land Commissioners executed a deed from the Commonwealth of Massachusetts to the United States of 12 tracts of land, each 50 by 50 feet, covered by the navigable waters of Buzzards Bay, at various points along the dredged approach channel to the canal, for the purpose of maintaining supporting structures and lights as aids to navigation.

On March 23, 1915, the Harbor and Land Commissioners executed a deed from the Commonwealth to the United States of a tract of land under water at the northeasterly end of the breakwater at the easterly entrance to the canal, in the town of Sandwich, for the purpose of maintaining a light and fog signal as aids to navigation.

On June 3, 1915, an order was issued by the Joint Board allowing the canal company a further period of time to Dec. 31, 1915, inclusive, for completing the canal.

Important questions having arisen with respect to the provisions of the contract between the canal company and the construction company, referred to above, particularly as to a lock, and the payment therefor, if one should be required, the opinion of the Attorney-General was requested. This opinion was received in July, 1915, and was to the effect that the construction of locks, tidal gates or other devices for controlling the current in the canal would not be a part of the work for which the canal company has contracted to pay $11,990,000 in stock and bonds, but would be additional work as provided for in the contract.

On Sept. 9 and Nov. 5, 1915, the Joint Board held public hearings relative to the construction of a lock, tidal gates or other device in the canal. The canal company, as well as the New York, New Haven & Hartford Railroad Company, which operates and controls a bridge across the canal near the Buzzards Bay Station, was represented, and testimony of towboat captains and others as to the necessity for a lock, and expression of their views generally with respect to the use thus far made of the canal, were offered. This important matter was still under consideration at the date of this report.

Certain correspondence has passed and inquiries have been made during the year concerning shoals within the dumping ground in Buzzards Bay between Abiel's Ledge and Dry Ledge used for dumping material dredged from the canal under permit from the Board of Harbor and Land Commissioners dated Jan. 3, 1912, it being alleged that these shoals were caused by the dumping done by the canal company at variance with the provisions of said permit. This matter is now being considered by this Board, the canal company and the United States District Engineer Officer stationed at Newport, R. I., with a view to adjustment.

LICENSES GRANTED DURING THE YEAR.

Nos.

3925. Petition of the city of Lawrence for approval of the plan for construction of a highway bridge over the Merrimac River, Lawrence, authorized by chapter 513, Acts of 1906, chapter 486, Acts of 1907, chapter 572, Acts of 1907, and chapter 749, Acts of 1914. Granted Dec. 2, 1914.

3926. Petition of Elliot H. Norton for license to build a pile and timber pier in Edgartown Harbor, at Chappaquiddick Island, Edgartown. Granted Jan. 5, 1915.

3927. Petition of Eugene Carpenter for license to build structures and fill solid in Deacons Pond Harbor, Falmouth. Granted Jan. 26, 1915.

3928. Petition of the Gulf Refining Company for license to build a pile wharf on Annisquam River, Gloucester. Granted Jan. 26, 1915.

Nos.

3929. Petition of Isaiah Spindell for license to build and maintain pile structures in Eel Pond at Woods Hole, Falmouth. Granted Jan. 26, 1915.

3930. Petition of George H. Turner for license to drive piles in Deacons Pond Harbor, Falmouth. Granted Jan. 27, 1915.

3931. Petition of Hiram N. Crowell for license to build a pile pier in Edgartown Harbor, Edgartown. Granted Jan. 27, 1915.

3932. Petition of Zebina B. Davis for license to build a stone pier in the east branch of Westport River, Westport. Granted Jan. 27, 1915.

3933. Petition of the town of Chilmark for license to maintain a wharf in Menamsha Inlet, in Chilmark and Gay Head. Granted Feb. 2, 1915.

3934. Petition of the New Bedford Gas and Edison Light Company for license to erect and maintain wires for the transmission of electricity over the tidewaters of Broad Marsh River, Wareham. Granted Feb. 2, 1915.

3935. Petition of the New Bedford Gas and Edison Light Company for license to erect and maintain wires for the transmission of electricity over the tidewaters of Beaver Dam Creek, Wareham. Granted Feb. 2, 1915.

3936. Petition of the New Bedford Gas and Edison Light Company for license to erect and maintain wires for the transmission of electricity over the tidewaters of the Weweantic River, in Marion and Wareham. Granted Feb. 2, 1915.

3937. Petition of the Cohasset Yacht Club for license to extend its club house on piles, and to locate and maintain floats in Cohasset Harbor, Cohasset. Granted Feb. 9, 1915.

3938. Petition of the Marconi Wireless Telegraph Company of America for license to suspend wires over and across the waters of Ryders Cove, Frost Fish or Cod Fish Creek and Stillwater Pond, Chatham. Granted Feb. 16, 1915.

3939. Petition of the New Bedford Gas and Edison Light Company for approval of plans to lay and maintain gas pipes and cables for the transmission of electricity under the tidewaters of Acushnet River between New Bedford and Fairhaven, as authorized by chapter 30 of the Acts of 1915. Granted March 3, 1915.

3940. Petition of the city of Haverhill for license to construct a submerged sewer outlet in Merrimac River at Groveland Street, Haverhill. Granted March 3, 1915.

3941. Petition of the Daniel A. Ward Company for license to build a bridge across North River Canal, Salem. Granted March 9, 1915.

3942. Petition of the Brockton & Plymouth Street Railway Company to erect and maintain wires for the transmission of electricity over Jones River, Kingston. Granted March 10, 1915.

Nos.

3943. Petition of Eleanor M. Anderson for license to build a concrete pier and boathouse in West Monponsett Pond, Halifax. Granted March 16, 1915.

3944. Petition of the Standard Oil Company of New York for license to build a concrete wall and pile wharf and to fill solid in Vineyard Haven Harbor, Tisbury. Granted March 24, 1915.

3945. Petition of the Marthas Vineyard Cold Storage and Ice Company for license to enlarge its wharf in Vineyard Haven Harbor, Tisbury. Granted March 24, 1915.

3946. Petition of Emulous A. Cahoon for license to build and maintain a pumping plant and draw water from Seymours Pond, Harwich. Granted March 24, 1915.

3947. Petition of the Naumkeag Steam Cotton Company for license to replace a portion of a sea wall, build an intake house and dredge a berth in Salem Harbor, Salem. Granted March 30, 1915.

3948. Petition of the New Bedford Gas and Edison Light Company for license to erect and maintain wires for the transmission of electricity over the tidewaters of West Creek, Fairhaven. Granted March 30, 1915.

3949. Petition of the New Bedford Gas and Edison Light Company for license to erect and maintain wires for the transmission of electricity over the tidewaters of Nasketucket River, Fairhaven. Granted March 30, 1915.

3950. Petition of the New Bedford Gas and Edison Light Company for license to erect and maintain wires for the transmission of electricity over the tidewaters of Mattapoisett River, Mattapoisett. Granted March 30, 1915.

3951. Petition of Louis Arenovski for license to build and maintain a pile wharf and a pile structure from the outer end of said wharf, in Lewis Bay, Hyannis. Granted March 30, 1915.

3952. Petition of the Fitchburg and Leominster Street Railway Company for license to build a boathouse as an enlargement or extension of its existing boathouse on Lake Whalom, Lunenburg. Granted March 31, 1915.

3953. Petition of the Kilburn Mill for license to build a sea wall and fill solid in Clarks Cove, New Bedford. Granted April 21, 1915.

3954. Petition of Fred C. Hubbard for license to drive piles, build and maintain a boat landing and a log boom on the Connecticut River, West Springfield. Granted April 21, 1915.

3955. Petition of William Wallace for license to build a pile pier in Nantucket Harbor, Nantucket. Granted April 21, 1915.

3956. Petition of the Young Men's Christian Association for license to build an addition to its bath house in Lake Whalom, Lunenburg. Granted April 21, 1915.

3957. Petition of W. M. W. Spring for license to build a pile pier and float stage on Bass River, Yarmouth. Granted April 27, 1915.

Nos.

3958. Petition of the Bay State Freezer, Inc., for license to build a pile wharf in Barnstable Harbor, Yarmouth. Granted April 27, 1915.

3959. Petition of the New Bedford, Marthas Vineyard and Nantucket Steamboat Company for license to rebuild and enlarge, on piles, a portion of its wharf in Nantucket Harbor, Nantucket. Granted May 4, 1915.

3960. Petition of Anna C. Stevenson for license to extend and enlarge a wharf in Lake Anthony, Oak Bluffs. Granted May 11, 1915.

3961. Petition of the town of Falmouth for license to build a pile wharf at the end of the county road at Megansett, Falmouth. Granted May 12, 1915.

3962. Petition of Charles V. Chipman for license to build a pile pier in Vineyard Haven Harbor, Oak Bluffs. Granted May 18, 1915.

3963. Petition of Harry E. Converse for license to replace an existing pile and timber wharf by a concrete and pile and timber structure, in Buzzards Bay, Marion. Granted May 18, 1915.

3964. Petition of R. Frank Waugh for license to build a pile platform and to locate a float and runway on South River, Salem. Granted May 18, 1915.

3965. Petition of the Boston & Maine Railroad for license to rebuild its bridge, known as bridge No. 14, on piles across Pines River in Revere and Saugus. Granted May 18, 1915.

3966. Petition of the Connecticut Valley Lumber Company for license to hang and maintain booms in and across the Connecticut River, in Gill and Montague. Granted May 19, 1915.

3967. Petition of the Connecticut Valley Lumber Company for license to hang and maintain booms in and across the Connecticut River, in Northampton and Hadley. Granted May 19, 1915.

3968. Petition of George E. Kunhardt for license to build a wall on Merrimac River, Lawrence. Granted May 25, 1915.

3969. Petition of the city of Salem for license to build a retaining wall and culvert and fill solid in South River, Salem. Granted May 25, 1915.

3970. Petition of the Turners Falls Power and Electric Company for approval of plans to construct a concrete dam on the easterly side of the Connecticut River, also two concrete spillways and a concrete sluiceway, in Montague and Gill, as authorized by chapter 122, Acts of 1854, chapter 148, Acts of 1880, and chapter 197, Acts of 1913. Granted May 25, 1915.

3971. Petition of the town of Marblehead for license to extend its wharf in Marblehead Harbor, Marblehead. Granted June 1, 1915.

3973. Petition of the city of Haverhill for license to build a timber bulkhead and fill solid on Merrimac River, Haverhill. Granted June 1, 1915.

Nos.

3974. Petition of Frank Vogel for license to build a boat landing on the Connecticut River at Riverside Park, Holyoke. Granted June 8, 1915.

3975. Petition of John Connors for license to build a sea wall and fill solid in Eel Pond at Woods Hole, Falmouth. Granted June 8, 1915.

3976. Petition of Frederic M. Briggs and Grace W. Briggs for license to build a pile pier and float stage in Pocasset Harbor, at Pocasset, Bourne. Granted June 8, 1915.

3977. Petition of Eugene Carpenter for license to build two pile piers in Lagoon Pond, Tisbury. Granted June 8, 1915.

3978. Petition of the Joseph A. Bowen Company for license to widen its wharf by building a sea wall and filling solid on Taunton River, Fall River. Granted June 15, 1915.

3979. Petition of the city of Salem for approval of plans as authorized by chapter 107 of the Special Acts of the year 1915, for the construction of a new highway in the extension of Congress Street and the building of a new highway bridge with a draw therein across South River, Salem. Granted June 22, 1915.

3980. Petition of the town of Scituate for approval of plans for construction of a wharf and public landing in and over the tidewaters of Scituate Harbor, Scituate, as authorized by chapter 508 of the Acts of 1914. Granted June 25, 1915.

3981. Petition of the Cape Cod & New Bedford Steamship Company for license to build a pile wharf in Onset Bay, at Onset, Wareham. Granted July 6, 1915.

3982. Petition of the Springfield Gas Light Company for license to lay a 6-inch gas main across Connecticut River, in Agawam and Longmeadow. Granted July 14, 1915.

3983. Petition of the Greenfield Electric Light and Power Company for license to lay submarine cables across Connecticut River, in Montague and Greenfield. Granted July 14, 1915.

3984. Petition of Mary A. Hart for license to build a pile pier in Vineyard Haven Harbor, Tisbury. Granted July 14, 1915.

3985. Petition of Andrew M. Norback for license to locate a floating boathouse on Lake Quinsigamond, Worcester. Granted July 14, 1915.

3986. Petition of Ella F. Haskell and Marilla T. Brown for license to build a pile pier and float in Annisquam River, at Thurstons Point, Gloucester. Granted July 14, 1915.

3987. Petition of William F. Keith and Eugene B. Somerby for license to build a boat landing in Massachusetts Bay at Winthrop Highlands, Winthrop. Granted July 14, 1915.

3988. Petition of the Boston Ice Company for license to maintain the present dam, and a gate and flashboards, at the outlet of Morse Pond, Wellesley. Granted July 21, 1915.

Nos.

3989. Petition of Joshua Crane for license to build a stone breakwater in tidewater at No Mans Land, Chilmark. Granted July 21, 1915.

3990. Petition of Joshua Crane for license to build a wharf in Red Brook Harbor, Bourne. Granted July 21, 1915.

3991. Petition of the Haverhill Box Board Company for license to build a bulkhead and fill solid on Merrimac River, Haverhill. Granted July 28, 1915.

3992. Petition of the Point of Pines Yacht Club, Inc., for license to build a club house, supported by concrete piers, and a pile pier, also to locate a float stage on Saugus River, Revere. Granted July 28, 1915.

3993. Petition of James P. Cammett for license to build a boat landing at the end of a wharf on Plum Island River at Grape Island, Ipswich. Granted Aug. 4, 1915.

3994. Petition of the Springdale Motor Boat Club for license to maintain a boat landing on Connecticut River, at Riverside Park, Holyoke. Granted Aug. 4, 1915.

3995. Petition of the Bristol Manufacturing Corporation for license to build a pile and timber bulkhead and to fill solid on Acushnet River, New Bedford. Granted Aug. 23, 1915.

3996. Petition of Emma L. Smith for license to extend a wharf on piles and to locate a float on Coles River, Swansea. Granted Aug. 23, 1915.

3997. Petition of the Union Street Railway Company for license to lay cables, for the transmission of electric current, in and under Acushnet River, at the east and west draw spans of the New Bedford and Fairhaven bridge, New Bedford. Granted Aug. 23, 1915.

3998. Petition of the Fiberloid Company for license to build a bulkhead and fill solid on Merrimac River, Newburyport. Granted Sept. 7, 1915.

3999. Petition of Henry Lang for license to build a pile and timber bulkhead, a pile pier and a marine railway, and to fill solid in Nantucket Harbor, Nantucket. Granted Sept. 15, 1915.

4000. Petition of the Springfield Gas Light Company for license to lay pipes in and under Connecticut River, and to build a pile and timber crib and fill solid in Connecticut River, Agawam. Granted Sept. 15, 1915.

4001. Petition of the county commissioners of the county of Hampshire for approval of plans for repairing the bridge known as the Connecticut River bridge between Northampton and Hadley, as authorized by chapter 709 of the Acts of 1914 and chapter 66 of the General Acts of 1915. Granted Sept. 15, 1915.

4002. Petition of the Merchants Terminal Warehouse Company for license to build bulkheads and fill solid on Acushnet River, New Bedford. Granted Sept. 21, 1915.

Nos.

4003. Petition of the city of Salem for approval of plans for laying a 36-inch cast-iron pipe across Danvers River in Salem, Beverly and Danvers, as authorized by chapters 169 and 316 of the Special Acts of 1915. Granted Oct. 5, 1915.

4004. Petition of the city of Salem for approval of plans for laying of a 36-inch cast-iron pipe across North River, Salem, as authorized by chapters 169 and 316 of the Special Acts of 1915. Granted Oct. 5, 1915.

4005. Petition of the city of Salem for license to build a gate house and lay a pipe in Wenham Lake, Beverly. Granted Oct. 5, 1915.

4006. Petition of the Bay State Street Railway Company for license to lay and maintain cables in Beverly Harbor at Essex bridge, in Salem and Beverly. Granted Oct. 5, 1915.

4007. Petition of Arthur B. Tunning for license to build a pile pier in Nantucket Harbor, Nantucket. Granted Oct. 5, 1915.

4008. Petition of the Crystal Lake Ice Company for license to make alterations in an existing ice intake in Crystal Lake, Newton. Granted Oct. 19, 1915.

4009. Petition of John Killen for license to build a bulkhead and fill solid in Nantucket Harbor, Nantucket. Granted Oct. 19, 1915.

4010. Petition of William W. Phinney for license to build a pile wharf and two marine railways, and to locate a float stage in Deacons Pond Harbor, Falmouth. Granted Oct. 20, 1915.

4011. Petition of George M. Wason for license to build a concrete sea wall and fill solid on Merrimac River, Haverhill. Granted Oct. 20, 1915.

4012. Petition of Sophia A. Brosnan for license to build a concrete sea wall and fill solid on Merrimac River, Haverhill. Granted Oct. 20, 1915.

4013. Petition of the town of Falmouth for license to build a pile wharf in Eel Pond at Woods Hole, Falmouth. Granted Oct. 26, 1915.

4014. Petition of the town of Barnstable for approval of plans for building a public wharf and landing in Lewis Bay, Barnstable, as authorized by chapter 356 of the Special Acts of 1915. Granted Oct. 26, 1915.

4015. Petition of the Bay State Street Railway Company for license to lay cables in Saugus River at Fox Hill bridge, in Lynn and Saugus. Granted Oct. 26, 1915.

4016. Petition of the Bay State Street Railway Company for license to lay cables in Taunton River at Slade's Ferry bridge, in Fall River and Somerset. Granted Oct. 26, 1915.

4017. Petition of the town of Dennis for approval of plans for the construction of a public wharf on piles, and landing, in the vicinity of the Old Corporation Wharf, Dennis, as authorized by chapter 351 of the Special Acts of 1915. Granted Oct. 26, 1915.

Nos.

4018. Petition of the town of Barnstable for approval of plans for building a public wharf and landing in Maraspin or Mill Creek, Barnstable, as authorized by chapter 342 of the Special Acts of 1915. Granted Oct. 26, 1915.

4019. Petition of the city of Lowell for license to build a reinforced concrete bridge across Merrimac River at the site of the Pawtucket bridge, Lowell. Granted Nov. 3, 1915.

4020. Petition of George F. Snow for license to build and maintain a dike and sluiceway, also a pumping plant, and to draw water from Wenham Pond, Carver. Granted Nov. 3, 1915.

MISCELLANEOUS PERMITS GRANTED AND FISH WEIR PERMITS APPROVED DURING THE YEAR.

WARRENS COVE WEIR COMPANY, to construct and maintain a fish weir in the tidewaters of Plymouth. Approval of license issued Nov. 30, 1914, by the selectmen of Plymouth. Granted Dec. 23, 1914.

WALTER F. NICKERSON, to construct and maintain a fish weir in the tidewaters of Eastham. Approval of permit issued Dec. 7, 1914, by the selectmen of Eastham. Granted Jan. 26, 1915.

ANTONE DE MOTT, to locate and maintain fish traps in the waters of Taunton River, Dighton. Approval of license issued Oct. 9, 1914, by the selectmen of Dighton. Granted Jan. 26, 1915.

EDMUND D. and EDMUND S. KENDRICK, to construct and maintain a fish weir in Pleasant Bay, Chatham. Approval of permit issued Jan. 18, 1915, by the selectmen of Chatham. Granted Jan. 26, 1915.

FRANK GRANT, to set fish traps and pots in Taunton River and its tributaries. Approval of license issued Jan. 15, 1915, by the selectmen of Dighton. Granted Jan. 26, 1915.

CHARLES GARDNER, to set fish traps in Taunton River and its tributaries. Approval of permit issued by the selectmen of Dighton Jan. 21, 1915. Granted Feb. 2, 1915.

JOHN KINGSBURY, to use and occupy Rat Island in Lake Winthrop, Holliston. Granted Feb. 2, 1915.

FRED W. BAKER, to construct and maintain a fish weir in Pleasant Bay, Chatham. Approval of permit issued by the selectmen of Chatham Feb. 4, 1915. Granted Feb. 9, 1915.

ROSCOE H. GOULD, to construct and maintain a fish weir in Chatham Bay, Chatham. Approval of permit issued by the selectmen of Chatham Feb. 5, 1915. Granted Feb. 9, 1915.

BENJAMIN F. RICH, to construct and maintain a fish weir in Pleasant Bay, Chatham. Approval of permit issued by the selectmen of Chatham Feb. 4, 1915. Granted Feb. 9, 1915.

FRANK P. TILTON, to construct and maintain a fish weir in Menamsha Pond, Chilmark. Approval of permit issued Feb. 8, 1915, by the selectmen of Chilmark. Granted Feb. 23, 1915.

Plymouth Electric Light Company, to erect and maintain wires over and across Jones River in the town of Kingston. Granted March 10, 1915.

Howard D. Sears, to construct and maintain a fish weir in the tidewaters of Dennis in Barnstable Bay. Approval of permit issued by the selectmen of the towns of Dennis and Yarmouth Jan. 29, 1915. Granted March 23, 1915.

Merwin H. Sears, to construct and maintain a fish weir in the tidewaters of Dennis in Barnstable Bay. Approval of permit issued by the selectmen of the towns of Dennis and Yarmouth Jan. 29, 1915. Granted March 23, 1915.

Edgar F. Wixon, to construct and maintain a fish weir in the tidewaters of Dennis. Approval of permit issued by the selectmen of the towns of Dennis and Yarmouth April 30, 1915. Granted March 23, 1915.

Nathaniel H. Wixon, to construct and maintain a fish weir in the tidewaters of Dennis. Approval of permit issued by the selectmen of the towns of Dennis and Yarmouth Feb. 23, 1915. Granted March 23, 1915.

Marine Biological Laboratory of Woods Hole, Mass., to construct and maintain a fish trap in the waters of Gosnold. Approval of permit issued by the selectmen of Gosnold March 19, 1915. Granted March 30, 1915.

William J. Grant, to set fish traps and pots in Taunton River. Approval of permit issued March 1, 1915, by the selectmen of Dighton. Granted March 30, 1915.

Stephen W. Fuller, to construct and maintain fish weirs in the waters of Yarmouth. Approval of permits issued by the selectmen of Yarmouth and Dennis March 19, 1915. Granted April 13, 1915.

Ernest Lyon, to remove sand and gravel from beach on the ocean side of Allerton, Hull. Granted April 15, 1915.

John W. Stubbs, to construct and maintain a fish weir in the waters of Wellfleet. Approval of license issued by the selectmen of Wellfleet March 27, 1915. Granted April 21, 1915.

Simon Berriv, to construct and maintain a fish weir in the waters of Wellfleet. Approval of license issued by the selectmen of Wellfleet March 27, 1915. Granted April 21, 1915.

Edward L. Burgess, to remove material from the beach at Warrens Cove, Plymouth. Granted April 27, 1915.

Joseph Wilfred Appleton, to remove material from North Scituate Beach. Granted May 4, 1915.

Obed S. Daggett, to construct and maintain a fish weir in the waters of Gosnold. Approval of permit issued by the selectmen of Gosnold April 20, 1915. Granted May 4, 1915.

Obed S. Daggett, to construct and maintain a fish weir in the waters of Gosnold, from the shore of Naushon Island at a point called the

"French Watering Place," about 1 mile west of Tarpaul Cove Lighthouse. Approval of permit issued by selectmen of Gosnold April 20, 1915. Granted May 4, 1915.

Fred C. Sanborn, to take material from the beach on the ocean side at Allerton, Hull. Granted May 4, 1915.

Sherburn M. Merrill, to take material from the beach on the ocean side at Allerton, Hull. Granted May 5, 1915.

W. H. Ellis & Son Company, to dredge three areas in Apponagansett or Padanaram Harbor, Dartmouth. Granted May 11, 1915.

Alice C. Goddard, to remove stones from the beach at Warrens Cove, Plymouth. Granted May 11, 1915.

Mary F. Stoddard, to remove stones from the beach at Warrens Cove, Plymouth. Granted May 11, 1915.

Lowell Cement Brick Company, authorized to give notice of its intention to place and operate a cable across Merrimac River from a point in North Chelmsford to a point near the filter plant in Lowell. Granted May 26, 1915.

John H. Driscoll, Jr., to use and occupy Berry Island in Lake Winthrop, Holliston. Granted June 1, 1915.

The Fall River Iron Works Company, to dredge in Mount Hope Bay, Fall River. Granted June 7, 1915.

L. H. Kunhardt, to excavate and deposit material in the northern part of Squeteague Pond in Cataumet. Granted June 16, 1915.

John M. Minton, and others, in relation to the construction by property owners of structures at the wall built by the Commonwealth from Gun Rock to the boundary line between the towns of Hull and Cohasset. Granted June 16, 1915.

F. A. Conroy, to remove material from a part of North Scituate Beach, Scituate. Granted June 24, 1915.

City of New Bedford, to dredge sewage deposits in Acushnet River, New Bedford. Granted July 19, 1915.

George C. Moss and **Albert H. Moss**, to remove a floating bath house from the waters of Lake Quinsigamond, Worcester. Granted Aug. 10, 1915.

Ellen M. Boardman, to remove gravel from Salters Beach, Plymouth. Granted Aug. 10, 1915.

Fall River Iron Works Company, for extension of time for dredging in front of wharf in Fall River. Granted Aug. 19, 1915.

Sven Hanson, to construct and maintain a fish trap in the waters of Rockport in the northern cove of Gully Point. Approval of permit issued by the selectmen of Rockport July 22, 1915. Granted Sept. 7, 1915.

Sven Hanson, to construct and maintain a fish trap in the waters of Rockport in the southwest cove of Straitsmouth Island. Approval of permit issued by the selectmen of Rockport March 12, 1914. Granted Sept. 7, 1915.

George C. Moss and Albert H. Moss, to remove a floating bath house from the waters of Lake Quinsigamond, Worcester. Granted Sept. 8, 1915.

Sylvestor M. Hanson, to construct and maintain a fish weir in Saquish Cove, Plymouth. Approval of license issued by the selectmen of Plymouth Sept. 7, 1915. Granted Sept. 15, 1915.

Goldthwait Trust, to dredge in Marblehead Harbor easterly of the causeway in Marblehead. Granted Sept. 29, 1915.

Augustus W. Baker, to set, maintain and fish a fyke in Frost Fish Creek in the town of Chatham. Approval of permit issued by the selectmen of Chatham Aug. 16, 1915. Granted Sept. 30, 1915.

Henry W. Breed, to dredge a channel in Lynn Harbor, Lynn. Granted Oct. 1, 1915.

Clarington E. Eldredge, to construct and maintain a fish weir in Chatham South Bay, Chatham. Approval of permit issued by the selectmen of Chatham Aug. 16, 1915. Granted Oct. 6, 1915.

Benjamin L. Jones, to construct and maintain a fish weir in Chatham South Bay, Chatham. Approval of permit issued by the selectmen of Chatham Aug. 16, 1915. Granted Oct. 6, 1915.

William M. Kendrick, to set, maintain and fish a fyke in a creek below Samuel Ryder Island, Chatham. Approval of permit issued by the selectmen of Chatham Aug. 16, 1915. Granted Oct. 6, 1915.

Benjamin H. Sisson, to construct and maintain a fish weir in the waters of Menamsha Pond. Approval of permit issued by the selectmen of Chilmark Sept. 17, 1915. Granted Oct. 6, 1915.

Orick D. Young, to set, maintain and fish a fyke in the Henry Harding Creek on the north side of Oyster Pond River, Chatham. Approval of permit issued by the selectmen of Chatham Aug. 16, 1915. Granted Oct. 6, 1915.

Orick D. Young, to set, maintain and fish a fyke in a creek in Howes Cove on the north side of Oyster Pond River, Chatham. Approval of permit issued by the selectmen of Chatham Aug. 16, 1915. Granted Oct. 6, 1915.

Plymouth Cordage Company, to dredge in Plymouth Harbor, Plymouth. Granted Oct. 18, 1915.

James R. Baker and Robert Clark, to erect and maintain a fish weir in the waters of the south shore of Yarmouth. Approval of permit issued by the selectmen of Yarmouth Dec. 31, 1912. Granted Oct. 19, 1915.

John B. Berry, to construct a fish trap in Mill Creek, Brewster. Approval of permit issued by the selectmen of Brewster Oct. 4, 1915. Granted Oct. 19, 1915.

Albertus E. Dugan, to construct a fish trap in Mill Creek, Brewster. Approval of permit issued by the selectmen of Brewster Oct. 4, 1915. Granted Oct. 19, 1915.

Edwin B. Ellis, to construct a fish trap in Mill Creek, Brewster. Approval of permit issued by the selectmen of Brewster Oct. 4, 1915. Granted Oct. 19, 1915.

Eugene B. Ellis, to construct two fish traps in Mill Creek, Brewster. Approval of permit issued by the selectmen of Brewster Oct. 4, 1915. Granted Oct. 19, 1915.

Joshua Paine, to use and occupy a portion of the Province Lands, Provincetown. Granted Oct. 19, 1915.

Fred Young, to construct two fish traps in Mill Creek, Brewster. Approval of permit issued by the selectmen of Brewster Oct. 4, 1915. Granted Oct. 19, 1915.

Fred Young, to construct a fish trap in Quivet Creek, Brewster. Approval of permit issued by the selectmen of Brewster Oct. 4, 1915. Granted Oct. 19, 1915.

Dexter H. Craig, to dredge a channel in Plymouth Harbor, Plymouth. Granted Oct. 26, 1915.

James R. Baker and **Robert Clark**, to set and maintain a fish weir in the waters of the town of Yarmouth at a point west of Parkers River. Approval of permit issued by the selectmen of Yarmouth Aug. 3, 1915. Granted Oct. 26, 1915.

Benjamin L. Jones, to construct and maintain a fish weir in Chatham South Bay, Chatham. Approval of permit issued by the selectmen of Chatham Oct. 18, 1915. Granted Oct. 26, 1915.

City of Fall River, to dredge in Mount Hope Bay at and near the wharf of the Bowenville Coal Company in Fall River. Granted Nov. 3, 1915.

Samuel A. Nickerson, to set eel fykes in the tidewaters of the town of Eastham. Approval of permit issued by the selectmen of Eastham July 31, 1915. Granted Nov. 17, 1915.

Conserving and Equalizing the Flow of Water in Rivers and Streams.

By chapter 113 of the Resolves of 1915 the Board is authorized and directed to investigate the matter of conserving and equalizing the flow of water in the rivers and natural streams of the Commonwealth, and authorized to expend for the purposes of this resolve during the years 1915, 1916 and 1917 not exceeding $20,000 in addition to the unexpended balance of an appropriation made to carry on an investigation of this matter under authority of chapter 95 of the Resolves of 1914.

Reference is made to a report of a special commission designated by chapter 129 of the Resolves of 1913 to investigate and report upon this matter, also a report of the Harbor and Land Commissioners under date of Jan. 13, 1915 (House Document No. 1725 of 1915), submitted in accordance with the requirements of chapter 95 of the Resolves of 1914, in which considerable information bearing on the matter of developed and undeveloped water power, etc., is given, as well as some of the problems involved in a complete and detailed investigation which it is intended that the resolve of 1915 aforesaid should cover.

In general, the scope of the inquiry has thus far included the Westfield River particularly, and a partial determination of what the water resources of the State are and to what extent these resources are now utilized, and what can be done in further utilizing such resources by means of greater equalization of the flow of streams or by means of storage reservoirs.

A report in detail, showing the results of the Board's investigation, will be submitted at a later date.

Total expenditure to Dec. 1, 1915, $1,657.70.

RE-ESTABLISHMENT OF CERTAIN TRIANGULATION POINTS.

By chapter 223 of the General Acts of 1915 the Board was authorized to make such surveys and do such other work as may be required by any order of the Land Court, to re-establish and permanently mark certain triangulation points and stations previously established in connection with the topographical survey of the Commonwealth and the town boundary survey, which have been lost or destroyed, and to obtain the geographical position of such new points and stations as may be required from time to time by the court. The Board was allowed to expend not exceeding $1,000 from the sum of $1,500 which may annually be paid out of the State treasury.

During the year stations have been relocated and new stations established in the towns of Harvard, Falmouth, Provincetown and Barnstable, and the geographical position of the same furnished to the Land Court.

Amount expended during the year, $792.32.

The foregoing report is respectfully submitted.

WILLIAM S. McNARY,
CHARLES C. PAINE,
GEORGE M. HARLOW,
Commissioners.

DEC. 1, 1915.

APPENDIX.

APPENDIX A.

[See page 4 of this report, *ante*.]

CONTRACTS MADE AND PENDING DURING THE YEAR 1915.

Contract No.	WORK.	Contractor.	Date.	Condition of Work.	Prices.	Amount.
177	Sandwich Harbor, building westerly jetty.	William Sears and James H. Connolly.	Apr. 7, 1914	Completed Feb. 1, 1915,	Stone in place, $3 per ton of 2,000 pounds; $10 per cubic yard of concrete measured in place.	$10,352 70
181	Duxbury Bay, dredging channels and basin.	J. S. Packard Dredging Company.	June 30, 1914	Completed Apr. 16, 1915,	Dredging, 32.9 cents per cubic yard, measured in scows. Excavating bowlders, $9 per cubic yard. Dredging and depositing material on land and flats, 35 cents per cubic yard, measured *in situ*.	12,839 30
184	Annisquam River, Gloucester, grading and riprapping portion of bank.	John Cashman & Sons Company.	June 23, 1914	Completed Jan. 1, 1915, .	Grading, etc., $1,050. Stone riprap in place, $1.87 per ton of 2,000 pounds.	12,481 55
184A	Annisquam River, Gloucester, grading and riprapping northerly bank.	John Cashman & Sons Company.	May 18, 1915	Completed June 22, 1915,	Grading, etc., $262.50. Stone riprap in place, $1.87 per ton of 2,000 pounds.	1,792 29
185	Ipswich River, Ipswich, concrete walls and timber bulkheads.	Rendle & Stoddard, . .	June 30, 1914	Partially completed, .	$2,324.	1,824 00
188	Nobscusset Point, Dennis, building pile and timber bulkhead.	William H. Connor, . .	Aug. 11, 1914	Completed Nov. 24, 1915,	$6,800.	7,185 27
188A	Nobscusset Point, Dennis, placing stone in breakwater.	Dennis F. Crowley, . .	Sept. 15, 1915	Completed Nov. 6, 1915,	For raising and straightening inshore portion of jetty, $150. For stone in place, $3 per ton of 2,000 pounds. For removing and placing bowlders from beach, $2 for each ton of 2,000 pounds. For mattress of brush in place, $100.	5,964 00

CONTRACTS MADE AND PENDING, ETC. — *Continued.*

Contract No.	WORK.	Contractor.	Date.	Condition of Work.	Prices.	Amount.
189	Wild Harbor, Falmouth, dredging channel and basin.	J. S. Packard Dredging Company.	Sept. 8, 1914	Completed Jan. 4, 1915, .	Dredging, 31.9 cents per cubic yard, measured in scows. Excavating bowlders, $9 per cubic yard. Dredging and depositing dredged material on land and flats, 32 cents per cubic yard, measured *in situ*.	$12,800 00
189A	Wild Harbor, Falmouth, dredging and stone jetty.	John R. Burke, . . .	Aug. 18, 1915	Completed Oct. 25, 1915,	Dredging, 36 cents per cubic yard, measured in scows. Stone in place, $2.60 per ton of 2,000 pounds.	2,186 60
191	Scituate Harbor, dredging channels and basin.	Bay State Dredging Company, Ltd.	Aug. 4, 1914	Completed Dec. 14, 1914,	Dredging, 27¼ cents per cubic yard, measured in scows. Excavating bowlders, $10 per cubic yard.	23,092 23
191A	Scituate Harbor, dredging channel,	Bay State Dredging Company, Ltd.	May 18, 1915	Completed Sept. 14, 1915,	Dredging, 27¼ cents per cubic yard, measured in scows. Excavating bowlders, $10 per cubic yard	3,932 77
192	Cataumet Harbor, dredging channel and basin.	J. S. Packard Dredging Company.	Aug. 11, 1914	Completed July 14, 1915,	Dredging, 34.29 cents per cubic yard, measured in scows. Excavating bowlders, $10 per cubic yard. Dredging and depositing material on land and flats, 36 cents per cubic yard, measured *in situ*.	30,111 58
194	South Hadley, Connecticut River, concrete wall.	Dennis F. Crowley, . .	May 5, 1915	Completed Aug. 31, 1915,	For excavating trench, etc., $2.90 per cubic yard of material excavated; $9.44 per cubic yard of concrete measured in place in completed work.	4,794 90
195	Apponagansett River, Dartmouth, dredging channel and basin.	John R. Burke, . . .	Aug. 11, 1914	Completed Feb. 5, 1915, .	Dredging, 32.9 cents per cubic yard, measured in scows. Excavating bowlders, $10 per cubic yard.	8,883 00
197	Saugus River, Lynn and Saugus, dredging channel and constructing dike.	Eastern Dredging Company, .	Oct. 6, 1914	In progress, . . .	Dredging, 29 cents per cubic yard, measured *in situ* or in scows. Building dike, $2 per lineal foot. Excavating bowlders, $7.50 per cubic yard.	90,500 00
200	Duxbury Bay, dredging extension to anchorage basin.	J. S. Packard Dredging Company.	Aug. 11, 1914	Completed May 5, 1915, .	Dredging, 32.9 cents per cubic yard, measured in scows. Excavating bowlders, $9 per cubic yard. Dredging and depositing material on land and flats, 35 cents per cubic yard, measured *in situ*.	4,965 30

201	Salters Point, Dartmouth, extension to breakwater.	E. S. Belden & Sons, . .	Aug. 11, 1914	Completed Dec. 12, 1914,	Stone furnished and placed, $1.47 per ton of 2,000 pounds.	5,049 57
203	Paskamansett River, Dartmouth, pile and timber jetty.	Frank C. Taylor, . . .	Dec. 15, 1914	Completed Feb. 27, 1915,	$11 per linear foot of jetty in place.	2,772 00
204	Annisquam River, Gloucester, removal of ledges.	Bay State Dredging Company, Ltd.	Dec. 15, 1914	Completed Sept. 4, 1915,	For removing ledges and disposing of same, $24 per cubic yard, measured in place.	5,001 60
205	New Bedford, pier and steel shed, .	W. H. Ellis & Son Company, .	Jan. 5, 1915	In progress, . . .	Estimated total, $316,872; unit prices.	316,872 00
206	Hatfield, Connecticut River, riprapping bank.	Daniel O'Connell's Sons, .	May 12, 1915	In progress, . . .	For furnishing and placing stone and all incidental work, $1.85 per ton of 2,000 pounds.	2,500 00
207	Scituate, sea wall and riprap between First and Second Cliffs.	Susi & Williams, . . .	Apr. 15, 1915	Completed June 10, 1915,	For furnishing materials and building concrete sea wall, $5.24 per cubic yard of concrete measured in place. For stone riprap, 85 cents per linear foot of crest of beach covered.	2,261 99
208	Deacons Pond Harbor, Falmouth, dredging channel and basin.	Eastern Dredging Company, .	Apr. 15, 1915	Completed July 20, 1915,	Dredging, 16.95 cents per cubic yard, measured in scows. Excavating bowlders, $9.50 per cubic yard.	9,318 77
209	Bass River, Dennis and Yarmouth, dredging channel.	Eastern Dredging Company, .	Apr. 15, 1915	In progress, . . .	Dredging, 26.75 cents per cubic yard, measured in scows. Excavating bowlders, $9.50 per cubic yard.	15,000 00
210	Hadley, Connecticut River, riprapping bank.	Daniel O'Connell's Sons, .	May 12, 1915	Completed Sept. 24, 1915,	For furnishing and placing stone, $2.12 per ton of 2,000 pounds.	1,895 56
211	Scituate Harbor, dredging basin and channel.	Bay State Dredging Company, Ltd.	May 5, 1915	Completed Sept. 15, 1915,	Dredging, 26.9 cents per cubic yard, measured in scows. Excavating bowlders, $10 per cubic yard. Dredging and disposing of dredged material within pier or its approaches, 46 cents per cubic yard, measured in place.	10,180 72
212	Vineyard Haven, Tisbury, concrete sea wall.	Herbert N. Hinckley, . .	May 12, 1915	Completed Nov. 9, 1915,	$6.75 per cubic yard of concrete, measured in place in the completed work.	7,836 75
212A	Vineyard Haven, Tisbury, extension of concrete sea wall.	Herbert N. Hinckley, . .	Nov. 11, 1915	In progress, . . .	$9 per cubic yard of concrete, measured in place in the completed work.	749 00
213	Menamsha Inlet, Chilmark, concrete sea wall.	Dennis F. Crowley, . .	May 12, 1915	Completed Aug. 26, 1915,	$6.40 per cubic yard of concrete, measured in place in the completed work.	2,781 27
214	Annisquam River, Gloucester, riprapping northerly bank.	John Cashman & Sons Company.	Apr. 13, 1915	Completed June 21, 1915,	For use of lighter, $55 per day of nine hours. For stone, $1.30 per ton of 2,000 pounds.	1,402 20

CONTRACTS MADE AND PENDING, ETC. — *Concluded.*

Contract No.	WORK.	Contractor.	Date.	Condition of Work.	Prices.	Amount.
215	Menamsha Inlet, Chilmark, dredging.	John R. Burke, . . .	June 1, 1915	Completed Oct. 14, 1915,	Dredging, 38.7 cents per cubic yard, measured in scows. Excavating bowlders, $5 per cubic yard.	$3,100 64
216	Gloucester Harbor, near Five Pound Island, dredging channel.	Bay State Dredging Company, Ltd.	June 1, 1915	Completed Oct. 29, 1915,	Dredging, 28 cents per cubic yard, measured in scows. Excavating bowlders, not exceeding 5 cubic yards, $6 per cubic yard. Excavating bowlders exceeding 5 cubic yards, $13 per cubic yard.	10,012 53
217	Chicopee, Connecticut River, retaining wall and riprap.	Way & Cellilli, . . .	June 9, 1915	Completed Oct. 23, 1915,	$5.85 per cubic yard of concrete, measured in place. For furnishing and placing stone, $1.35 per ton of 2,000 pounds.	5,069 63
218	Holyoke, Connecticut River, dike and riprap.	Daniel O'Connell's Sons, .	June 9, 1915	Completed Oct. 16, 1915,	For building dike, 50 cents per cubic yard of material measured in place in completed dike. For furnishing and placing stone, $1.78 per ton.	3,713 83
219	Warrens Cove, Plymouth, concrete sea wall.	Concrete Construction Company.	June 9, 1915	Completed Sept. 24, 1915,	$5.70 per cubic yard of concrete, measured in place in the completed work.	2,480 11
220	Mill River, Gloucester, dredging channel.	Bay State Dredging Company, Ltd.	June 9, 1915	Completed July 27, 1915,	Dredging, 29.5 cents per cubic yard, measured in scows. Excavating bowlders, $9 per cubic yard.	2,867 45
221	Bucks Creek, Chatham, timber jetty.	William L. Miller Company, .	June 16, 1915	Completed July 31, 1915,	$9.44 per linear foot of pile and timber jetty in place.	2,416 64
222	Cuttyhunk Harbor, widening channel.	Jeremiah P. O'Riorden, .	June 16, 1915	Completed Aug. 12, 1915,	Dredging, 21 cents per cubic yard, measured in scows. Excavating bowlders, $5 per cubic yard.	4,307 31
223	Cohasset Harbor, dredging channel.	Jeremiah P. O'Riorden, .	June 16, 1915	Completed July 19, 1915,	Dredging, 23 cents per cubic yard, measured in scows. Excavating bowlders, $5 per cubic yard.	2,129 80
224	Wellfleet Harbor, dredging channel and basin.	John H. Gerrish, . . .	Aug. 4, 1915	Not commenced, . .	Dredging, 14.3 cents per cubic yard, measured in scows. Excavating bowlders, $6 per cubic yard.	8,151 00
225	Ipswich River, Ipswich, dredging channel.	John H. Gerrish, . . .	Aug. 10, 1915	In progress, . . .	Dredging, 31.7 cents per cubic yard, measured in scows. Excavating bowlders, $6 per cubic yard.	10,000 00

226	Plymouth Harbor, dredging basin,	Eastern Dredging Company, .	Aug. 4, 1915	Completed Oct. 16, 1915,	Dredging, 14 cents per cubic yard, measured in scows. Excavating bowlders, $9.50 per cubic yard.	7,000 00
228	Lynn Harbor, enlarging anchorage basin.	J. S. Packard Dredging Company.	July 21, 1915	In progress, . . .	For dredging and disposing of dredged material as provided, $30,000.	30,000 00
229	Nobscusset Harbor, Dennis, dredging channel and basin.	John H. Gerrish, . . .	Aug. 4, 1915	Not commenced, . .	Dredging, 18.3 cents per cubic yard, measured in scows or *in situ*. Excavating bowlders, $8 per cubic yard.	9,418 00
230	Barnstable Harbor, dredging channel and basin.	John H. Gerrish, . . .	Aug. 4, 1915	Not commenced, . .	Dredging, 16.3 cents per cubic yard, measured *in situ*. Excavating bowlders, $6 per cubic yard.	14,250 00
231	Vineyard Haven Harbor, Tisbury, enlarging breakwater.	Bay State Dredging Company, Ltd.	Aug. 4, 1915	Completed Oct. 20, 1915,	For furnishing stone and depositing it in place, $1.34 per ton of 2,000 pounds. For furnishing and setting in place each iron clamp, $5.	9,452 88
233	Concord River, Billerica, removing bowlders.	Cape Ann Granite Corporation.	Sept. 21, 1915	In progress, . . .	Excavating bowlders and ledges and disposing of same, $7.50 per ton of 2,000 pounds.	1,477 50
234	Winthrop, shore protection, . .	William L. Miller Company, .	Nov. 5, 1915	Not commenced, . .	$6.09 per cubic yard of concrete measured in place in the completed work; $6.50 for each linear foot of pile and timber jetty in place; $6.33 for each linear foot of pile and timber bulkhead in place.	17,000 00
235	Lewis Bay, Barnstable and Yarmouth, dredging channels and basin.	John R. Burke, . . .	Sept. 22, 1915	In progress, . . .	Dredging, 23.4 cents per cubic yard, measured in scows. Excavating bowlders, $10 per cubic yard.	8,000 00
236	Sandwich Harbor, repairing jetty, .	Rockport Granite Company, .	Sept. 7, 1915	Completed Nov. 9, 1915,	For stone furnished and in place, $2.90 per ton of 2,000 pounds.	5,686 90
237	Brant Rock, Marshfield, repairing sea wall.	Dennis F. Crowley, . .	Oct. 27, 1915	Not commenced, . .	$5.20 per day for masons; $2.50 per day for laborers; $6 per day for two-horse teams, including driver; $30 per week for foreman; $2 per barrel for Portland cement; plus 15 per cent.	1,000 00
238	Scituate, Third Cliff, repairing riprap.	Dennis F. Crowley, . .	Nov. 2, 1915	In progress, . . .	For furnishing and placing stone, $2.45 per ton of 2,000 pounds.	735 00
239	Warrens Cove, Plymouth, concrete sea wall.	Dennis F. Crowley, . .	Nov. 5, 1915	In progress, . . .	$5.70 per cubic yard of concrete measured in place in the completed work.	4,189 50
241	Nobscusset Harbor, Dennis, removal of stone and bowlders.	Dennis F. Crowley, . .	Sept. 15, 1915	Completed, . . .	For removing not less than 250 tons of stone and bowlders and placing same against timber breakwater, $500.	500 00

APPENDIX B.

CONTRIBUTIONS AND EXPENDITURES FOR RIVER AND HARBOR WORK UNDER DIRECTION OF THE HARBOR AND LAND COMMISSIONERS, MADE DURING THE YEAR ENDING NOV. 30, 1915, UNDER CHAPTER 481, ACTS OF 1909, AND CHAPTER 642, ACTS OF 1912.

LOCATION.	Character of Work.	Contribution by Municipality or Others.	Expenditure.
Acushnet River,	Inspection,	-	$2 15
Agawam, Connecticut River,	Advertising and prints,	-	844 68
Annisquam River, Gloucester,	Riprap,	-	13,145 95
Apponagansett River, Dartmouth,	Inspection and prints,	-	5 29
Barnstable Harbor,	Survey,	-	19 25
Bass River, Dennis-Yarmouth,	Dredging,	$2,500 00	10,547 95
Brant Rock, Marshfield,	Survey,	-	3 60
Bucks Creek, Chatham,	Jetty,	-	2,592 24
Cataumet Harbor and Squeteague Pond, Bourne and Falmouth.	Advertising and inspection,	-	841 04
Chicopee, Connecticut River,	Wall and riprap,	-	5,337 54
Cohasset Harbor, Cohasset and Scituate.	Dredging,	-	2,392 81
Concord River, Billerica,	Removing bowlders,	150 00	168 71
Cuttyhunk Harbor, Gosnold,	Dredging,	-	7,770 31
Deacons Pond Harbor, Falmouth,	Dredging,	2,000 00	10,290 16
Dennis Harbor,	Survey,	-	22 12
Duxbury Bay, Duxbury,	Dredging,	-	9,830 69
East Bay, Osterville,	Removing scow,	-	400 00
Fall River Harbor,	Survey and prints,	-	14 46
Falmouth Heights, Falmouth,	Sea wall,	-	2,785 13
Gloucester Harbor,	Dredging and removing ledges.	-	7,086 37
Hadley, Connecticut River,	Riprap,	-	7,247 47
Hatfield, Connecticut River,	Riprap,	-	96 67
Herring River, Harwich,	Inspection,	-	59 16
Holyoke, Connecticut River,	Dike and riprap,	415 00	3,673 71
Hull,	Inspection,	-	3 00
Ipswich River, Ipswich,	Wall, bulkhead and dredging,	-	1,236 25

CONTRIBUTIONS, ETC. — *Concluded.*

LOCATION.	Character of Work.	Contribution by Municipality or Others.	Expenditure.
Lynn Harbor and Saugus River,	Dredging,	-	$75 74
Manchester Harbor,	Dredging,	-	3,978 97
Menamsha Inlet, Chilmark,	Sea wall and dredging,	-	5,913 61
Merrimac River,	Survey,	-	555 06
Mill River, Gloucester,	Dredging,	$300 00	3,170 33
Miscellaneous expenses,	- - - -	-	1,512 16
New Bedford Harbor,	Prints,	-	96
Nobscusset Harbor, Dennis,	Riprap and breakwater,	-	3,491 32
Paskamansett River, Dartmouth,	Jetty,	-	2,926 34
Plymouth Harbor,	Dredging,	500 00	6,897 92
Rock Harbor, Orleans,	Advertising,	-	3 23
Rockport Harbor,	Dredging,	-	957 24
Salt Pond River,	Advertising,	-	1 25
Salters Point, Dartmouth,	Breakwater,	-	5,424 56
Sandwich Harbor,	Jetty, riprap,	-	11,790 69
Scituate,	Sea walls,	235 00	2,555 72
Scituate Harbor,	Dredging,	-	21,529 26
Smiths Cove, Gloucester,	Inspection,	-	3 00
South River, Salem,	Survey,	-	64 72
South Watuppa Pond, Fall River,	Fender pier,	-	200 00
Stage Harbor, Chatham,	Survey,	-	1,508 28
Taunton River,	Inspection,	-	1 60
Taunton-Brockton Waterway,	Investigation,	-	709 08
Vineyard Haven, Tisbury,	Sea wall,	630 50	6,942 19
Waquoit Bay,	Survey,	-	370 78
Warrens Cove, Plymouth,	Sea wall,	3,244 77	2,038 59
Wellfleet Harbor,	Prints,	-	2 00
Wild Harbor, Falmouth,	Dredging and jetty,	-	14,744 55
Winthrop Shore Protection,	Survey,	-	9 65
		$9,975 27	$183,795 51

APPENDIX C.

Appropriations, Contributions and Expenditures for River and Harbor Work under the Direction of the Board of Harbor and Land Commissioners, from 1893 to 1915, inclusive.

[Excepting Boston main harbor.]

Locality.	Character of Work.	Total Appropriation.	Contribution by Municipality or Others.	Total Expenditure.
Acushnet River,	Inspection,	$2 15	-	$2 15
Allens Harbor, Harwich,	Survey,	219 50	-	219 50
Annisquam River, Gloucester,	Dredging, removing ledges and riprap.	107,615 42	-	107,245 54
Apponagansett Harbor and River, Dartmouth.	Survey, dredging and stone breakwater.	50,522 30	-	50,148 76
Barnstable Harbor,	Survey and dredging,	13,736 76	$1,500 00	274 11
Bass River, Beverly,	Dredging,	25,539 81	55,535 75	81,075 56
Bass River, Dennis-Yarmouth,	Jetties, dredging and survey.	62,482 68	2,500 00	63,497 68
Brant Rock, Marshfield,	Survey,	3 60	-	3 60
Bucks Creek, Chatham,	Jetties, survey and dredging.	13,460 90	1,000 00	14,289 58
Buzzards Bay, Falmouth,	Survey,	162 86	-	162 86
Cataumet Harbor and Squeteague Pond, Bourne and Falmouth.	Dredging,	26,364 79	7,350 00	33,570 88
Centerville River, Barnstable,	Dredging,	6,103 22	1,500 00	7,603 22
Cohasset Harbor, Cohasset and Scituate.	Breakwater and dredging.	33,571 29	20,691 88	54,263 17
Concord River, Billerica,	Removing bowlders,	168 71	150 00	168 71
Connecticut River,	Investigation of navigation and surveys.	10,637 04	-	6,970 99
Agawam,	Protective work,	20,396 09	-	18,814 42
Chicopee,	Survey, wall and riprap.	15,244 96	640 00	15,884 96
Hadley,	Protective work,	88,965 04	500 00	86,262 33[1]
Hatfield,	Dikes,	12,045 42	1,000 00	12,246 17
Holyoke,	Dredging and protective work.	18,258 71	415 00	3,673 71
Northampton,	Protective work,	1,525 80	-	1,524 20
South Hadley,	Sea wall,	4,072 74	1,000 00	5,045 96
West Springfield,	Protective work,	5,135 00	-	5,051 49[2]
Conservation of waters,	Investigation,	15,000 00	-	1,657 70
Cotuit Harbor, Barnstable,	Dredging,	31,471 85	2,000 00	30,443 74

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[1] From 1888, inclusive.

[2] From 1891, inclusive.

APPROPRIATIONS, ETC. — *Continued.*

LOCALITY.	Character of Work.	Total Appropriation.	Contribution by Municipality or Others.	Total Expenditure.
Cuttyhunk Harbor, Gosnold, .	Jetties and dredging,	$53,546 68	$8,000 00	$61,472 61
Deacons Pond Harbor, Falmouth.	Dredging and jetties,	46,001 03	14,000 00	60,001 03
Dorchester, easterly shore, Boston.	Dredging, . . .	70,363 66	-	70,171 31
Duxbury Bay and Harbor, Duxbury.	Dredging, . . .	19,254 20	-	19,254 20
East Bay, Osterville, . .	Jetties, dredging and removing scow.	23,672 10	-	23,337 54
Edgartown Harbor, . . .	Survey, . . .	205 65	-	205 65
Essex County Beaches, . .	Survey, . . .	1,000 00	-	1,000 00
Essex River, Essex, . . .	Dredging, . . .	5,000 00	-	5,000 00[1]
Fall River Harbor, . . .	Improvement, . .	350,014 46	-	785 69
Falmouth Heights, Falmouth, .	Sea wall, . . .	4,625 22	1,000 00	5,625 22
Gloucester Harbor, . . .	Dredging and removing ledges.	12,016 96	-	12,016 96
Green Harbor, Marshfield, .	Jetties and dredging,	90,670 95	-	76,333 26
Harbor Cove, Gloucester, .	Survey and dredging,	15,670 07	-	15,670 07
Harbor View, Boston, . .	Dredging, . . .	10,146 00	-	146 00
Herring River, Harwich, . .	Jetties and dredging,	32,512 97	2,000 00	34,293 67
Herring River, Wellfleet, . .	Dike and ditches, .	11,832 74	10,000 00	21,800 73
Hingham Harbor, ...	Dredging, . . .	13,180 69	3,000 00	16,180 69
Houghs Neck, Quincy, . .	Dredging, . . .	4,499 83	500 00	4,999 83
Housatonic River, Sheffield, .	Survey, . . .	2,011 29	-	2,011 29
Hull, ...	Sea wall and survey, .	25,238 32	9,000 00	34,120 38
Humarock Beach, Scituate, .	Survey, . . .	250 00	-	236 07
Hyannisport, Barnstable, .	Survey and breakwater.	21,826 25	2,500 00	24,326 25
Improvement of rivers and harbors.	General expenses, .	3,079 85	-	3,079 85
Ipswich River, Ipswich, . .	Jetty, wall and dredging.	17,715 42	1,000 00	18,708 86
Island End River, Everett, .	Survey, . . .	264 10	-	264 10
Jeffries Point, Boston, . .	Dredging, . . .	10,000 00	-	-
Lake Anthony, Oak Bluffs, .	Jetties and dredging,	47,599 90	2,000 00	46,390 86
Lake Quannapowitt, Wakefield,	Investigation, . .	1,004 21	-	345 32
Lewis Bay, Barnstable, . .	Survey and dredging,	26,260 65	-	17,660 91
Little River, Gloucester, . .	Survey, . . .	862 93	-	862 93
Lobster Cove, Gloucester, .	Dredging, . . .	17,603 98	1,500 00	19,103 98
Lynn Harbor, ...	Survey and dredging,	62,154 43	5,200 00	37,088 92
Lynn Harbor and Saugus River, Lynn, Saugus and Revere.	Dredging and filling,	50,075 74	35,000 00	60,954 09
Manchester Harbor, . . .	Jetties and dredging,	46,228 56	35,500 00	81,706 40

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[1] Expended by United States government.

APPROPRIATIONS, ETC. — *Continued.*

LOCALITY.	Character of Work.	Total Appropriation.	Contribution by Municipality or Others.	Total Expenditure.
Menamsha Inlet, Chilmark and Gay Head.	Jetties and dredging,	$62,947 74	$700 00	$63,544 09
Merrimac River, . . .	Investigation and survey.	662 05	-	562 05
Mill River, Gloucester, . .	Survey and dredging,	24,620 94	300 00	24,887 67
Nantucket Harbor, . . .	Dredging, . . .	42,058 63	1,000 00	42,779 78
Neponset River, Boston and Quincy.	Dredging, . . .	34,270 44	-	34,269 70
New Bedford Harbor, . .	Pier, shed and dredging.	350,005 76	-	118,283 79
Nobscusset Harbor, Dennis, .	Breakwater, dredging and riprap.	12,752 81	1,200 00	4,034 62
North River, Marshfield, .	Surveys and removing rocks.	6,858 75	1,800 00	8,658 75
Oak Bluffs, ...	Removing rocks, .	500 00	-	462 50
Onset Bay, Wareham, . .	Survey and dredging,	14,067 89	1,000 00	15,067 89
Orient Heights, Boston, . .	Dredging, . . .	8,500 00	-	8,144 52
Pamet River, Truro, . .	Survey, . . .	1,214 98	200 00	1,414 98
Paskamansett River, Dartmouth.	Dredging and jetty, .	5,227 68	-	5,227 68
Penikese Island, Gosnold, .	Pile wharf and survey,	5,300 00	-	5,192 95
Plum Island River, Newbury and Newburyport.	Survey, . . .	983 31	-	983 31
Plymouth Harbor, . . .	Dredging, . . .	162,351 25	71,794 55	234,143 53[1]
Province Lands, Provincetown,	Reclamation, . .	68,000 00	-	65,568 60
Provincetown Harbor, . .	Survey, . . .	207 41	-	207 41
Quansett Harbor, Orleans, .	Survey, . . .	195 88	-	194 50
Quick's Hole, Gosnold, . .	Survey, . . .	500 00	-	-
Revere, ...	Stone breakwater, .	60,407 09	-	60,397 93
Rock Harbor, Orleans, . .	Dredging, . . .	12,108 25	400 00	12,492 71
Rockport Harbor, . . .	Dredging and removing rocks.	13,545 68	-	12,865 38
Salem Harbor, ...	Survey, . . .	1,050 05	-	1,050 05
Salt Pond River, . . .	Advertising, . .	1 25	-	1 25
Salters Point, Dartmouth, .	Breakwater, . .	13,460 72	1,500 00	14,960 72
Sandwich Harbor, . . .	Dredging, riprap and jetties.	51,100 94	-	51,100 94
Saugus River, Lynn and Saugus.	Survey and dredging,	19,206 64	2,000 00	20,845 17
Scituate, ...	Sea walls and riprap, .	43,788 89	235 00	42,684 02
Scituate Harbor, . . .	Dredging, . . .	56,836 95	8,300 00	65,136 95
Scorton Harbor, Sandwich, .	Jetty and dredging, .	19,426 39	500 00	17,774 34
Sesuit Harbor, Dennis, . .	Jetty, . . .	24,484 05	1,000 00	20,471 30
Shirley Gut, Boston and Winthrop.	Dredging, . . .	1,906 20	-	1,906 20
Sippican Harbor, Marion, .	Survey, . . .	7 17	-	7 17

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[1] $83,500 to be expended under direction of United States government.

APPROPRIATIONS, ETC. — *Concluded.*

LOCALITY.	Character of Work.	Total Appropriation.	Contribution by Municipality or Others.	Total Expenditure.
Sippowissett, Falmouth,	Survey,	$3 25	–	$3 25
Smith's Cove, Gloucester,	Survey and dredging,	5,162 35	–	5,162 30
South Boston, southerly shore,	Dredging,	126,972 48	–	126,972 44
South River, Salem,	Dredging,	10,522 75	$3,000 00	13,461 76
South Watuppa Pond, Fall River.	Fenders and excavation.	203 42	–	203 42
Stage Harbor, Chatham,	Dikes and survey,	10,740 21	–	10,740 21
Stony Beach, Hull,	Sea wall,	11,607 90	–	11,335 07
Taunton River,	Survey and investigation.	5,532 99	–	1,960 51
Taunton-Brockton Waterway,	Investigation,	3,209 08	–	3,059 08
Taunton River-Boston Harbor Canal.	Survey,	10,000 00	–	9,932 75
Vineyard Haven,	Sea walls,	6,311 69	630 50	6,942 19
Vineyard Haven Harbor, Tisbury.	Breakwater and dredging.	45,089 48	1,000 00	44,038 37
Waquoit Bay, Falmouth,	Survey,	1,370 78	–	1,072 39
Wareham River,	Survey,	941 44	–	941 44
Warrens Cove, Plymouth,	Sea wall,	888 59	3,244 77	2,038 59
Watch Hill, Chatham,	Survey and riprap,	15,020 47	–	14,968 75
Wellfleet Harbor,	Survey,	16,857 97	1,500 00	564 38
West Bay, Barnstable,	Jetties and dredging,	45,460 82	–	45,423 45
West Falmouth Harbor, Falmouth.	Dredging,	25,655 31	–	24,386 18
Weymouth Fore River, Quincy, Braintree, Weymouth.	Dredging,	38,991 19	–	24,066 70
Wild Harbor, Falmouth,	Survey and dredging,	15,070 73	5,000 00	15,013 86
Winthrop Harbor Channel,	Dredging,	18,959 21	700 00	17,704 63
Winthrop Harbor, Cottage Park,	Dredging,	6,603 00	–	6,581 66
Winthrop Shore,	Sea wall,	15,009 65	3,000 00	196 70
Witchmere Harbor, Harwich,	Jetties and dredging,	28,662 06	1,000 00	29,519 36
Wollaston Beach, Quincy,	Dredging,	15,066 00	–	14,644 61
Woods Hole, Great Harbor, Falmouth.	Dredging,	5,468 86	1,500 00	6,968 86
Wrecks,	Removal from tidewater.	65,516 66	–	7,005 08
		$3,328,549 61	$338,487 45	$2,775,486 10

APPENDIX D.

[See page 105 of this report, *ante*.]

AREAS OF COUNTIES, CITIES AND TOWNS OF MASSACHUSETTS, AS OF NOV. 30, 1915.

	Acres.	Square Miles.
Barnstable County.		
Barnstable,	40,155.0	62.74
Bourne,	26,584.0	41.54
Brewster,	16,102.9	25.16
Chatham,	10,441.9	16.31
Dennis,	14,016.5	21.90
Eastham,	9,341.4	14.60
Falmouth,	29,259.9	45.72
Harwich,	14,339.8	22.41
Mashpee,	16,617.1	25.96
Orleans,	9,081.1	14.19
Provincetown,	5,600.6	8.75
Sandwich,	27,914.8	43.62
Truro,	13,825.5	21.60
Wellfleet,	13,326.0	20.82
Yarmouth,	16,337.9	25.53
Totals (15),	262,944.4	410.85
Berkshire County.		
Adams,	14,729.3	23.02
Alford,	7,407.7	11.58
Becket,	30,742.0	48.04
Cheshire,	17,642.0	27.57
Clarksburg,	8,147.8	12.72
Dalton,	13,970.6	21.83
Egremont,	12,100.7	18.91
Florida,	15,815.2	24.71
Great Barrington,	29,342.6	45.86
Hancock,	22,774.7	35.59
Hinsdale,	13,864.4	21.66
Lanesborough,	18,921.4	29.56
Lee,	17,350.5	27.11
Lenox,	13,811.7	21.58
Monterey,	17,424.4	27.23
Mount Washington,	14,296.8	22.34
New Ashford,	8,737.7	13.65
New Marlborough,	30,745.8	48.04
NORTH ADAMS,	13,250.9	20.70
Otis,	24,254.5	37.90
Peru,	16,707.4	26.10
PITTSFIELD,	27,155.0	42.43
Richmond,	12,199.5	19.06
Sandisfield,	33,909.6	52.98
Savoy,	23,114.3	36.11
Sheffield,	31,150.7	48.67
Stockbridge,	15,169.4	23.70
Tyringham,	12,145.8	18.98
Washington,	24,814.2	38.78
West Stockbridge,	11,913.2	18.61
Williamstown,	29,989.2	46.86
Windsor,	22,567.7	35.26
Totals (32),	606,166.7	947.14
Bristol County.		
Acushnet,	12,041.3	18.82
ATTLEBORO,	17,774.3	27.77

AREAS OF COUNTIES, ETC. — *Continued.*

	Acres.	Square Miles.		Acres.	Square Miles.
Bristol County — Con.			GLOUCESTER,	16,929.3	26.45
Berkley,	10,495.9	16.40	Groveland,	5,994.5	9.37
Dartmouth,	39,559.7	61.82	Hamilton,	9,594.1	14.99
Dighton,	14,305.8	22.35	HAVERHILL,	22,934.0	35.83
Easton,	18,844.9	29.44	Ipswich,	21,340.7	33.35
Fairhaven,	7,934.5	12.40	LAWRENCE,	4,636.4	7.24
FALL RIVER,	24,371.9	38.08	LYNN,	7,177.2	11.21
Freetown,	23,173.6	36.21	Lynnfield,	6,713.0	10.49
Mansfield,	13,092.0	20.46	Manchester,	4,940.3	7.72
NEW BEDFORD,	12,688.4	19.83	Marblehead,	2,830.6	4.42
North Attleborough,	12,451.8	19.45	Merrimac,	5,778.0	9.03
Norton,	18,817.7	29.40	Methuen,	14,752.1	23.05
Raynham,	13,263.5	20.72	Middleton,	9,256.2	14.46
Rehoboth,	30,371.9	47.46	Nahant,	679.7	1.06
Seekonk,	11,957.5	18.68	Newbury,	15,577.6	24.34
Somerset,	5,446.3	8.51	NEWBURYPORT,	5,700.6	8.91
Swansea,	14,586.8	22.79	North Andover,	17,809.9	27.83
TAUNTON,	31,099.2	48.59	Peabody,	10,758.3	16.81
Westport,	35,349.6	55.24	Rockport,	4,528.9	7.08
Totals (20),	367,626.6	574.42	Rowley,	12,179.9	19.03
Dukes County.			SALEM,	5,233.5	8.18
Chilmark,	14,181.1	22.16	Salisbury,	10,325.1	16.13
Edgartown,	18,718.1	29.25	Saugus,	7,412.3	11.58
Gay Head,	4,062.0	6.34	Swampscott,	1,981.4	3.10
Gosnold,	8,286.5	12.95	Topsfield,	8,227.7	12.86
Oak Bluffs,	4,642.8	7.25	Wenham,	5,252.5	8.21
Tisbury,	4,824.4	7.54	West Newbury,	9,381.1	14.66
West Tisbury,	17,072.5	26.68	Totals (34),	329,234.8	514.43
Totals (7),	71,787.4	112.17	*Franklin County.*		
Essex County.			Ashfield,	25,807.3	40.32
Amesbury,	8,841.1	13.81	Bernardston,	15,048.0	23.51
Andover,	20,471.1	31.99	Buckland,	12,841.8	20.07
BEVERLY,	9,832.0	15.36	Charlemont,	16,961.3	26.50
Boxford,	15,611.3	24.39	Colrain,	27,791.4	43.42
Danvers,	8,857.4	13.84	Conway,	24,254.8	37.90
Essex,	9,201.1	14.38	Deerfield,	21,481.6	33.57
Georgetown,	8,495.9	13.27	Erving,	9,113.0	14.24

AREAS OF COUNTIES, ETC. — *Continued.*

	Acres.	Square Miles.		Acres.	Square Miles.
Franklin County — Con.			Southwick, . . .	20,345.2	31.79
Gill, ...	9,421.0	14.72	SPRINGFIELD, . . .	21,175.8	33.08
Greenfield, . . .	13,980.9	21.84	Tolland, ...	21,001.8	32.82
Hawley, ...	19,857.0	31.02	Wales, ...	10,390.8	16.23
Heath, ...	15,991.8	24.97	West Springfield, . .	11,224.5	17.54
Leverett, . . .	14,668.2	22.92	Westfield, . . .	30,419.0	47.53
Leyden, ...	11,657.7	18.22	Wilbraham, . . .	14,406.5	22.51
Monroe, ...	6,969.0	10.89	Totals (23), . .	407,108.6	636.11
Montague, . . .	20,503.0	32.04	*Hampshire County.*		
New Salem, . . .	19,414.4	30.34	Amherst, . . .	17,785.8	27.79
Northfield, . . .	22,556.0	35.24	Belchertown, . . .	33,804.5	52.82
Orange, ...	22,917.2	35.81	Chesterfield, . . .	20,060.6	31.34
Rowe, ...	15,390.5	24.05	Cummington, . .	14,836.3	23.18
Shelburne, . . .	15,015.5	23.46	Easthampton, . .	8,736.0	13.65
Shutesbury, . . .	17,410.6	27.20	Enfield, ...	11,306.3	17.66
Sunderland, . . .	9,458.8	14.78	Goshen, ...	11,336.3	17.71
Warwick, . . .	24,088.0	37.64	Granby, ...	18,083.7	28.26
Wendell, ...	20,425.4	31.93	Greenwich, . . .	12,612.7	19.71
Whately, . . .	13,321.4	20.82	Hadley, ...	15,863.4	24.78
Totals (26), . .	446,345.6	697.42	Hatfield, . . .	10,878.7	17.00
Hampden County.			Huntington, . . .	17,143.6	26.78
Agawam, . . .	15,583.1	24.35	Middlefield, . . .	15,518.9	24.25
Blandford, . . .	34,184.9	53.41	NORTHAMPTON, . .	22,796.1	35.62
Brimfield, . . .	22,735.7	35.52	Pelham, ...	15,746.6	24.60
Chester, ...	23,745.0	37.10	Plainfield, . . .	13,691.6	21.40
CHICOPEE, . . .	15,381.1	24.04	Prescott, ...	11,827.7	18.48
East Longmeadow, .	8,347.7	13.04	South Hadley, . .	11,782.3	18.41
Granville, . . .	27,698.9	43.28	Southampton, . .	18,556.0	29.00
Hampden, . . .	12,605.2	19.70	Ware, ...	18,494.7	28.90
Holland, ...	8,270.0	12.92	Westhampton, . .	17,523.4	27.38
HOLYOKE, . . .	14,628.8	22.86	Williamsburg, . .	16,403.9	25.64
Longmeadow, . .	6,157.8	9.62	Worthington, . . .	20,555.4	32.12
Ludlow, ...	18,226.5	28.48	Totals (23), . .	375,344.5	586.48
Monson, ...	28,772.4	44.96	*Middlesex County.*		
Montgomery, . . .	9,684.8	15.13	Acton, ...	12,999.1	20.31
Palmer, ...	20,568.4	32.14	Arlington, . . .	3,572.1	5.58
Russell, ...	11,554.7	18.06	Ashby, ...	15,324.0	23.94

AREAS OF COUNTIES, ETC. — *Continued.*

	Acres.	Square Miles.
Middlesex County — Con.		
Ashland,	8,292.0	12.96
Ayer,	5,979.8	9.34
Bedford,	8,866.8	13.85
Belmont,	2,983.1	4.66
Billerica,	16,617.1	25.96
Boxborough,	6,653.7	10.40
Burlington,	7,603.3	11.88
CAMBRIDGE,	4,570.3	7.14
Carlisle,	9,884.3	15.44
Chelmsford,	14,692.4	22.96
Concord,	16,492.2	25.77
Dracut,	13,630.9	21.30
Dunstable,	10,993.6	17.18
EVERETT,	2,396.7	3.75
Framingham,	16,347.0	25.54
Groton,	21,245.0	33.19
Holliston,	12,222.0	19.10
Hopkinton,	17,870.0	27.92
Hudson,	7,559.2	11.81
Lexington,	10,641.0	16.63
Lincoln,	9,550.1	14.92
Littleton,	11,098.4	17.34
LOWELL,	9,131.3	14.27
MALDEN,	3,285.1	5.13
MARLBOROUGH,	14,104.7	22.04
Maynard,	3,425.6	5.35
MEDFORD,	5,609.5	8.76
MELROSE,	3,070.2	4.80
Natick,	10,233.0	15.99
NEWTON,	11,733.0	18.33
North Reading,	8,661.2	13.53
Pepperell,	14,710.7	22.99
Reading,	6,305.8	9.85
Sherborn,	10,959.0	17.12
Shirley,	10,259.0	16.03
SOMERVILLE,	2,637.9	4.12
Stoneham,	4,264.5	6.66
Stow,	11,478.4	17.94
Sudbury,	15,676.8	24.50
Tewksbury,	13,382.9	20.91
Townsend,	21,010.0	32.83
Tyngsborough,	11,427.0	17.86
Wakefield,	5,046.8	7.89
WALTHAM,	8,650.1	13.52
Watertown,	2,671.5	4.17
Wayland,	10,159.8	15.88
Westford,	19,838.4	31.00
Weston,	11,111.1	17.36
Wilmington,	10,958.7	17.12
Winchester,	4,018.6	6.28
WOBURN,	8,388.4	13.11
Totals (54),	540,293.1	844.21
Nantucket County.		
Nantucket,	32,221.6	50.34
Totals (1),	32,221.6	50.34
Norfolk County.		
Avon,	2,876.0	4.50
Bellingham,	12,073.5	18.91
Braintree,	9,223.1	14.41
Brookline,	4,367.5	6.82
Canton,	12,404.0	19.38
Cohasset,	6,438.0	10.06
Dedham,	6,906.0	10.79
Dover,	9,796.0	15.28
Foxborough,	13,315.0	20.80
Franklin,	17,281.9	27.00
Holbrook,	4,686.9	7.32
Medfield,	9,292.9	14.52
Medway,	7,463.7	11.66
Millis,	7,849.4	12.26
Milton,	8,448.1	13.20
Needham,	8,162.0	12.75
Norfolk,	9,825.5	15.35

AREAS OF COUNTIES, ETC. — *Continued.*

	Acres.	Square Miles.
Norfolk County — Con.		
Norwood, ...	6,780.5	10.59
Plainville, ...	7,349.9	11.48
QUINCY, ...	10,648.3	16.64
Randolph, ...	6,607.9	10.32
Sharon, ...	15,557.6	24.34
Stoughton, ...	10,492.2	16.39
Walpole, ...	13,498.6	21.09
Wellesley, ...	6,730.0	10.51
Westwood, ...	7,196.0	11.24
Weymouth, ...	11,338.0	17.72
Wrentham, ...	14,516.1	22.68
Totals (28), . .	261,124.6	408.01
Plymouth County.		
Abington, ...	6,487.6	10.14
Bridgewater, ...	18,012.9	28.14
BROCKTON, ...	13,744.7	21.48
Carver, ...	25,333.1	39.58
Duxbury, ...	15,685.1	24.51
East Bridgewater, . .	11,338.8	17.72
Halifax, ...	11,117.4	17.36
Hanover, ...	10,006.2	15.63
Hanson, ...	10,124.0	15.82
Hingham, ...	14,454.5	22.59
Hull, ...	1,621.5	2.53
Kingston, ...	12,179.8	19.03
Lakeville, ...	23,140.5	36.16
Marion, ...	9,157.7	14.30
Marshfield, ...	18,250.7	28.52
Mattapoisett, ...	11,189.0	17.48
Middleborough, . .	46,690.0	72.96
Norwell, ...	13,653.0	21.33
Pembroke, ...	14,887.5	23.26
Plymouth, ...	66,042.0	103.20
Plympton, ...	9,721.1	15.19
Rochester, ...	23,066.0	36.04
Rockland, ...	6,471.1	10.11
Scituate, ...	10,921.7	17.07
Wareham, ...	24,338.0	38.03
West Bridgewater, . .	10,082.6	15.75
Whitman, ...	4,473.1	6.98
Totals (27), . .	442,189.6	690.92
Suffolk County.		
BOSTON, ...	28,957.8	45.25
CHELSEA, ...	1,391.8	2.17
REVERE, ...	4,045.5	6.32
Winthrop, ...	1,039.4	1.62
Totals (4), . .	35,434.5	55.36
Worcester County.		
Ashburnham, . . .	26,172.0	40.89
Athol, ...	21,168.0	33.07
Auburn, ...	10,520.0	16.44
Barre, ...	28,681.8	44.82
Berlin, ...	8,437.1	13.18
Blackstone, ...	10,405.9	16.26
Bolton, ...	12,789.7	19.99
Boylston, ...	12,653.8	19.77
Brookfield, ...	17,362.5	27.13
Charlton, ...	28,132.5	43.96
Clinton, ...	4,617.1	7.21
Dana, ...	12,150.8	18.98
Douglas, ...	24,371.0	38.08
Dudley, ...	14,061.0	21.97
FITCHBURG, ...	18,134.0	28.33
Gardner, ...	14,618.9	22.84
Grafton, ...	14,923.8	23.32
Hardwick, ...	25,546.9	39.92
Harvard, ...	17,267.2	26.98
Holden, ...	23,166.2	36.20
Hopedale, ...	3,371.9	5.26
Hubbardston, . . .	26,692.0	41.71
Lancaster, ...	17,877.0	27.93
Leicester, ...	15,695.1	24.52
Leominster, ...	18,883.0	29.51

AREAS OF COUNTIES, ETC. — *Concluded.*

	Acres.	Square Miles.		Acres.	Square Miles.
Worcester County — Con.			Southborough,	9,865.9	15.42
Lunenburg,	17,594.0	27.49	Southbridge,	13,270.5	20.74
Mendon,	11,482.0	17.94	Spencer,	21,774.0	34.02
Milford,	9,594.1	14.99	Sterling,	20,239.0	31.62
Millbury,	10,487.0	16.38	Sturbridge,	24,939.0	38.96
New Braintree,	13,436.4	21.00	Sutton,	21,726.0	33.95
North Brookfield,	14,074.2	21.99	Templeton,	20,635.0	32.24
Northborough,	11,978.0	18.72	Upton,	13,958.0	21.81
Northbridge,	11,493.0	17.96	Uxbridge,	19,093.0	29.83
Oakham,	13,584.9	21.23	Warren,	17,788.5	27.80
Oxford,	17,528.0	27.39	Webster,	9,282.0	14.50
Paxton,	9,854.9	15.40	West Boylston,	8,819.1	13.78
Petersham,	24,969.0	39.02	West Brookfield,	13,575.0	21.21
Phillipston,	15,547.4	24.29	Westborough,	13,767.0	21.51
Princeton,	22,850.0	35.70	Westminster,	23,744.6	37.10
Royalston,	27,155.0	42.43	Winchendon,	28,088.0	43.89
Rutland,	23,111.0	36.11	WORCESTER,	24,642.8	38.50
Shrewsbury,	13,968.8	21.83	Totals (59),	1,001,614.3	1,565.02

Recapitulation.

COUNTIES.	Cities.	Towns.	Cities and Towns.	Acres.	Square Miles.	AREAS, INCLUDING TIDEWATER TO THREE-MILE LIMIT.	
						Acres.	Square Miles.
BARNSTABLE, .	-	15	15	262,944.40	410.851	684,181.7	1,069.03
BERKSHIRE, . .	2	30	32	606,166.70	947.135	-	-
BRISTOL, . .	4	16	20	367,626.60	574.417	443,743.8	693.35
DUKES, . .	-	7	7	71,787.40	112.168	319,829.0	499.73
ESSEX, . . .	7	27	34	329,234.80	514.430	484,694.1	757.33
FRANKLIN, . .	-	26	26	446,345.55	697.415	-	-
HAMPDEN, . .	3	20	23	407,108.65	636.107	-	-
HAMPSHIRE, . .	1	22	23	375,344.45	586.476	-	-
MIDDLESEX, . .	11	43	54	540,293.11	844.208	-	-
NANTUCKET, .	-	1	1	32,221.60	50.345	185,580.0	289.97
NORFOLK, . .	1	27	28	261,124.60	408.007	276,945.1	432.73
PLYMOUTH, . .	1	26	27	442,189.60	690.921	598,878.6	935.75
SUFFOLK, . .	3	1	4	35,434.50	55.366	79,049.6	123.51
WORCESTER, . .	2	57	59	1,001,614.30	1,565.020	-	-
TOTALS, . .	35	318	353	5,179,436.26	8,092.866	3,072,901.9	4,801.40

	AREAS, INCLUDING TIDEWATER TO THREE-MILE LIMIT.	
	Acres.	Square Miles.
Shore counties, ...	3,072,901.91	4,801.40
Inland counties, ...	3,376,872.76	5,276.36
Grand total, ...	6,449,774.67	10,077.76

Jurisdictional area, 10,078 square miles.
Land area, as per note, 8,093 square miles.

NOTE. — Land areas of cities and towns along the coast are measured to high water line, and in tidal streams to the first bridge from the mouth of the same. Inland cities and towns include all ponded areas, and to the middle of rivers and streams where they form boundary lines.

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